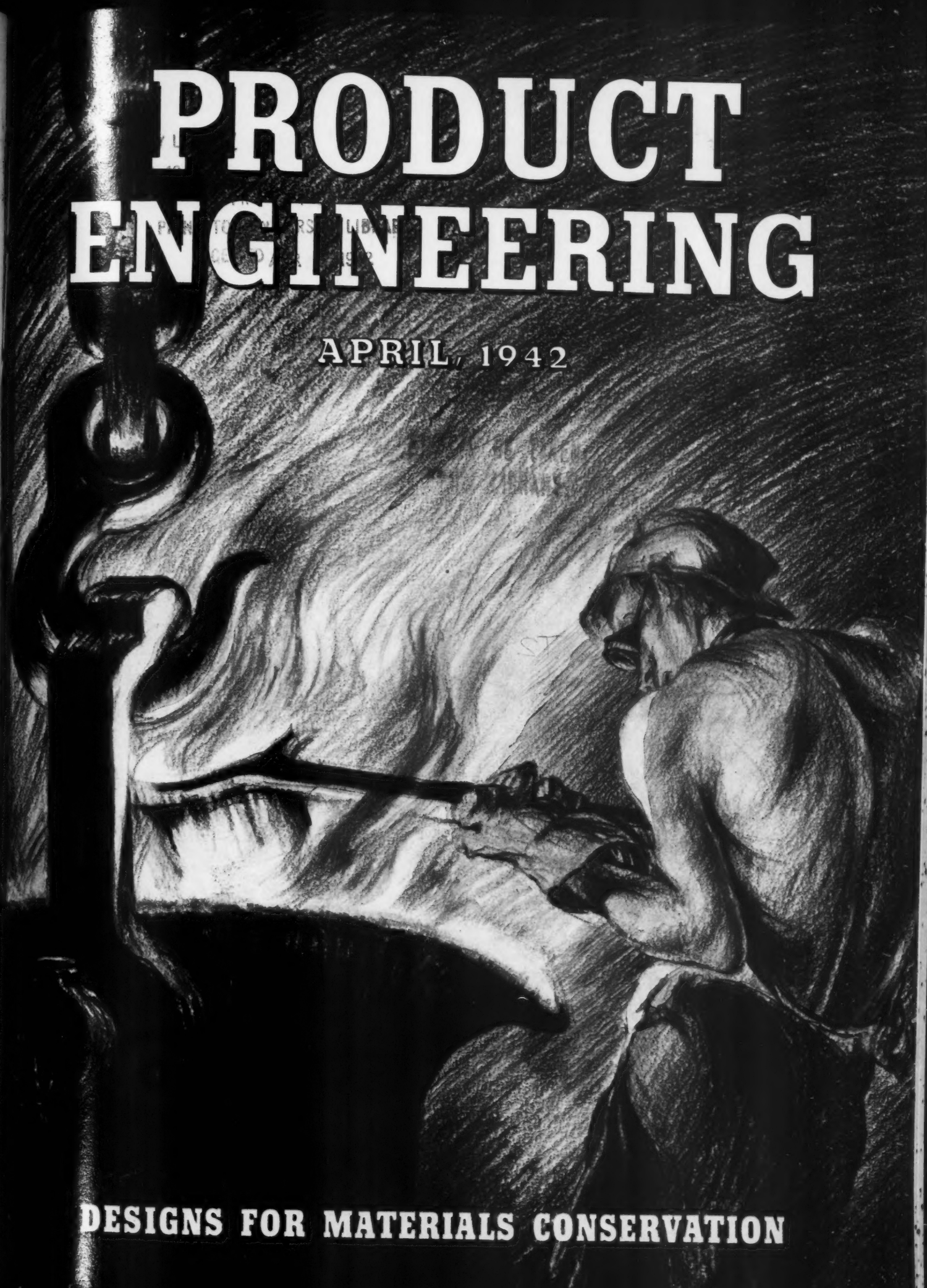
# PRODUCT ENGINEERING

APRIL, 1942



DESIGNS FOR MATERIALS CONSERVATION

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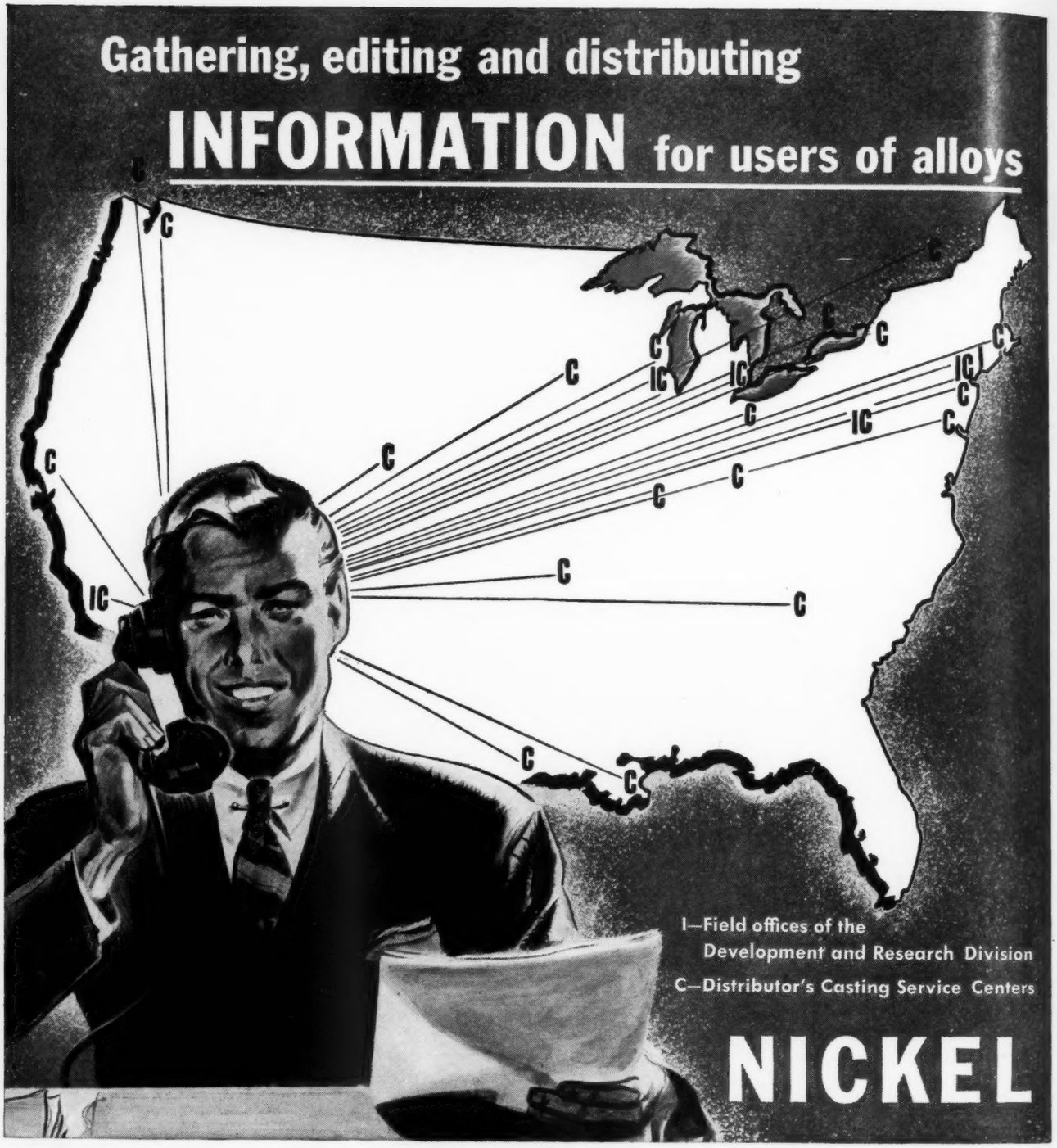


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# PRODUCT ENGINEERING

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## IN THIS ISSUE

### Materials Conservation

Several hundred materials-conserving design changes that have been made and tested are shown in detail on 66 pages of this issue—typical designs collected from all types of industries.

*Now:* PRODUCT ENGINEERING shows how the design engineer can achieve, in the face of materials shortages, the faster production urgently needed through new uses for new materials, new uses for old materials, and better designs requiring less materials.

*When War is Over:* This big collection of ideas will point to new materials and more efficient design techniques which can be incorporated in designs for the future.

## WHAT'S COMING

### Sleeve Bearings

Factors in sleeve bearing design, such as finish, material, lubrication and size have definite relationships, but just how they are tied together is hard to understand. Beginning in May, Bruno Sachs, design engineer with Johnson Bronze Company, will help the design engineer coordinate these factors in what promises to be an extremely comprehensive article, complete with all facts and figures.

### Tarnish Films on Metal Surfaces

There are many times when information on the tarnish rate of a metallic surface is extremely valuable. For instance: design of electrical circuits where metallic contacts are exposed to tarnishing atmosphere. Next month Alfred M. Suggs of P. R. Mallory & Company will describe a method to analyze tarnish by measuring light absorption.

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PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

# Designing for Materials Conservation

WHEN ARMED CONFLICT suddenly plunged America from an economy of plenty into one of scarcity, design engineers were forced to face problems that were tougher and more important than any they had ever encountered. They had to revise their designs to meet the demands for materials conservation. Perhaps a few became dismayed. But those designers who recognized that many of the previously existing standards had to be discarded and that an entirely new design philosophy had to be created to cope with the new conditions were rewarded with success.

During the two decades which preceded this period of war, design engineers had an almost unlimited variety of materials from which to select. The urge was to use the best. If the use of a lower quality material meant a sacrifice in the quality of the finished product, the possibility of its use was ruled out. Lower standards were both unthinkable and unmarketable.

Rapidly the demands for highest qualities spread. The trend and tempo of the times made it profitable and thereby necessary to specify materials better than essentially required. Buying habits developed ideas that cost and quality were synonymous. Qualities far beyond those necessary for the satisfactory functioning of the machine were called for by the design. It helped sales and from that viewpoint was fully justified. Empirical standards which justified the lavish use of the aristocrats of the materials kingdom became established.

Thus, for the past several decades the materials possessing outstanding qualities of strength, durability, corrosion resistance and other properties, have held the limelight. Costly alloys ranked high in our estimation and because they were esteemed we learned much about them. Because they attracted so much attention, many engineers neglected to keep fully abreast of the design possibilities in the proper use of the humbler materials. And the improvements that were being made in the materials of grandfather's day, failed to attract the attention deserved.

When materials suddenly became scarce and it was put up to the American design engineers to conserve to the last ounce, those who realized that only a new design philosophy could solve the problems succeeded. They threw aside the old standards of excellence, the restrictions imposed by sales considerations and "the habits of the trade." They established new standards of product quality that were based on the changed conditions. They surveyed the world of materials old and new, seeking those least scarce that would serve the purpose. Quality merely for quality's sake was abandoned. And in the successful fulfillment of the efforts of the design engineers, "every goose became a swan and every lass a queen."

The complete story of the accomplishments of design engineers in the conservation of materials will never be told; it is too big. But on the pages that follow is shown how dozens of designers have solved their problems by substitutions for scarcer materials and by design simplifications that reduced the amount of materials required. Many of the redesigns illustrate a return to fundamentals and how the ingenious use of ordinary materials solved the problem. All of the examples shown demonstrate the resourcefulness of the American design engineers.

Frankly, the story is a compilation of facts, data and the records of achievements. All the information was furnished by design engineers of industry. Without their cooperation this presentation would have been impossible. To all of those engineers who gave of their time so generously and who were unstinted in their cooperation to make this presentation possible, the editors of PRODUCT ENGINEERING extend their thanks and appreciation.

# NATIONAL EMERGENCY STEEL SPECIFICATIONS

In recognition of the fact that many of the simpler steels are, to all practical purposes, useable for applications wherein high-alloy steeels have been used, the War Production Board sponsored a program looking to the establishment of National Emergency Steel Specifications. The aim was to concentrate steel production on a minimum number of alternate steels that could be used in place of steels that contain the strategic elements nickel, chromium, tungsten, cobalt and vanadium. Obviously, if these strategic elements were reserved for the manufacture of alloy steels essential in the design of fighting equipment, the materials problem in that more important field would be less critical. Guns, projectiles and armor plate require combinations of these strategic alloys, otherwise the American military forces would not be the best equipped in the world.

With the rapid increase in production for the victory program it soon became evident that unless the alloying elements in steels were conserved there would not be enough of these strategic materials to supply both the essential non-military industry requirements and the War program requirements.

IN ANTICIPATION of the shortage in strategic alloy elements, the War Production Board called upon representatives of the American Iron & Steel Institute (A.I.S.I.), Society of Automotive Engineers (S.A.E.) and other technical societies and various interested manufacturers to meet and draw up National Emergency Steel Specifications. It is to the credit of all the parties involved that this program was put through with speed and efficiency. Cooperation from all the parties involved was enthusiastic and they considered the magnitude of the undertaking of such emergency specifications.

By force of necessity it is certain that these national emergency steels plus a few others containing none or only small amounts of strategic elements will soon be the only steels available. It is therefore imperative that the engineering departments of industry take the necessary steps to change over as quickly as possible from the previously used high alloy steels, the supply of which will soon be cut off entirely, to the corresponding National Emergency Specifications. Industry is urged to use carbon and inter-

**Table I—Analyses of National Emergency Steels**

| S.A.E. or A.I.S.I. Number | C | Mn | Ni | Cr | Mo |
|---|---|---|---|---|---|
| A 4027 | 0.25–0.30 | 0.70–0.90 | — | — | 0.20–0.30 |
| A 4037 | 0.35–0.40 | 0.75–1.00 | — | — | 0.20–0.30 |
| A 4063 | 0.60–0.67 | 0.75–1.00 | — | — | 0.20–0.30 |
| A 4068 | 0.64–0.72 | 0.75–1.00 | — | — | 0.20–0.30 |
| NE 8024 | 0.22–0.28 | 1.00–1.30 | — | — | 0.10–0.20 |
| NE 8124 | 0.22–0.28 | 1.30–1.60 | — | — | 0.25–0.35 |
| NE 8233 | 0.30–0.36 | 1.30–1.60 | — | — | 0.10–0.20 |
| NE 8245 | 0.42–0.49 | 1.30–1.60 | — | — | 0.10–0.20 |
| NE 8339 | 0.35–0.42 | 1.30–1.60 | — | — | 0.20–0.30 |
| NE 8442 | 0.38–0.45 | 1.30–1.60 | — | — | 0.30–0.40 |
| NE 8447 | 0.43–0.50 | 1.30–1.60 | — | — | 0.30–0.40 |
| NE 8547 | 0.43–0.50 | 1.30–1.60 | — | — | 0.40–0.60 |
| NE 8620 | 0.18–0.23 | 0.70–0.95 | 0.40–0.60 | 0.40–0.60 | 0.15–0.25 |
| NE 8630 | 0.27–0.33 | 0.70–0.95 | 0.40–0.60 | 0.40–0.60 | 0.15–0.25 |
| NE 8724 | 0.22–0.28 | 0.70–0.95 | 0.40–0.60 | 0.40–0.60 | 0.20–0.30 |
| NE 8739 | 0.35–0.42 | 0.75–1.00 | 0.40–0.60 | 0.40–0.60 | 0.20–0.30 |
| NE 8744 | 0.40–0.47 | 0.75–1.00 | 0.40–0.60 | 0.40–0.60 | 0.20–0.30 |
| NE 8749 | 0.45–0.52 | 0.75–1.00 | 0.40–0.60 | 0.40–0.60 | 0.20–0.30 |
| NE 8817 | 0.15–0.20 | 0.70–0.95 | 0.40–0.60 | 0.40–0.60 | 0.30–0.40 |
| NE 8949 | 0.45–0.52 | 1.00–1.30 | 0.40–0.60 | 0.40–0.60 | 0.30–0.40 |

All of the above steels contain 0.20–0.35 silicon and 0.040 maximum each of sulphur and phosphorus.
In addition to the above the usual plain carbon (1000 series), high-sulphur (1100 series), high-phosphorus (1200 series), silico manganese (9200 series) steels are available in the various carbon ranges, as are, also, certain other carbon molybdenum (4000 series) steels.

mediate manganese steels (1000-1100-1200 series); carbon molybdenum (4000 series); manganese molybdenum (8000-8100-8200-8300-8400-8500 series), or silico manganese (9200 series), wherever possible.

The conservation of alloying elements in these specifications is based upon the principle that small quantities of several different alloys are more effective than large quantities of any single element.

The analyses of the alternate steels which will be available are given in Table I. In Table II are given existing steel specifications along with the equivalent National Emergency Steel Specifications. Shortly these steels will be obtainable from all the regular sources of supply. Heats have already been made by a number of companies including the following:

Bethlehem Steel Corporation
Carnegie-Illinois Steel Company
Copperweld Steel Company
Pittsburgh Crucible Steel Company
Republic Steel Corporation
Rotary Electric Steel Company
Timken Steel and Tube Company
Youngstown Sheet and Tube Company

In the early stages of this program it may not be possible for a user to obtain the exact bar size or shape to which he is accustomed and it may be necessary to accept some other size or possibly even a forged bar in order to carry out a test program.

These recommended steels, together with existing S.A.E. equivalents, are described in the new Iron and Steel Institute Manual No. 5, entitled "Possible Alternates for Nickel, Chromium and Chromium-Nickel Constructional Alloy Steels."

Steels containing the strategic elements should be used only for important functional parts.

## Table II—Standard Steels and National Emergency Equivalents

| STANDARD SERIES DESIGNATION | | | | POSSIBLE ALTERNATES | | |
|---|---|---|---|---|---|---|
| | | | | S.A.E. or A.I.S.I. Number | | |
| 1942 A.I.S.I. Number | 1941 A.I.S.I. Number | 1942 S.A.E. Number | 1941 S.A.E. Number | Number | Number | Number |
| A 1320 | A 1321 | 1320 | — | A 4027 | NE 8024 | |
| A 1330 | A 1330 | 1330 | 1330 | A 4037 | NE 8233 | |
| A 1340 | A 1340 | 1340 | 1340 | A 4047 | NE 8245 | |
| A 2317 | A 2317 | 2317 | 2315 | A 4027 | NE 8024 | NE 8620 |
| A 2330 | A 2330 | 2330 | 2330 | A 4037 | NE 8233 | NE 8630 |
| A 2335 | A 2335 | — | — | A 4063 | NE 8339 | NE 8739 |
| A 2340 | A 2340 | 2340 | 2340 | A 4068 | NE 8442 | NE 8744 |
| A 2345 | — | 2345 | 2345 | A 4068 | NE 8447 | NE 8749 |
| WD 2350 | — | — | — | A 4068 | NE 8547 | NE 8949 |
| A 2515 | A 2514 | 2515 | 2515 | A 4027 | NE 8817 | |
| A 3045 | A 3045 | — | — | A 4068 | NE 8442 | NE 8744 |
| A 3120 | A 3120 | 3120 | 3120 | A 4027 | NE 8024 | NE 8620 |
| A 3130 | A 3130 | 3130 | 3130 | A 4037 | NE 8233 | NE 8630 |
| A 3135 | A 3135 | 3135 | 3135 | A 4063 | NE 8339 | NE 8739 |
| A 3140 | A 3140 | 3140 | 3140 | A 4068 | NE 8442 | NE 8744 |
| A 3141 | A 3141 | 3141 | X 3140 | A 4068 | NE 8447 | NE 8749 |
| A 3145 | A 3145 | 3145 | 3145 | A 4068 | NE 8447 | NE 8749 |
| A 3150 | A 3150 | 3150 | 3150 | A 4068 | NE 8547 | NE 8949 |
| A 3240 | A 3240 | 3240 | 3240 | A 4068 | NE 8442 | NE 8744 |
| WD 3250 | — | — | — | A 4068 | NE 8547 | NE 8949 |
| A 4119 | A 4119 | 4119 | — | A 4027 | NE 8024 | |
| A 4130 | A 4130 | 4130 | X 4130 | A 4037 | NE 8233 | NE 8630 |
| A 4137 | A 4137 | 4137 | — | A 4063 | NE 8339 | NE 8739 |
| A 4142 | A 4142 | — | — | A 4063 | NE 8442 | NE 8744 |
| A 4145 | — | 4145 | — | A 4068 | NE 8447 | NE 8749 |
| A 4150 | — | 4150 | 4150 | A 4068 | NE 8547 | NE 8949 |
| A 4320 | A 4320 | 4320 | 4320 | — | NE 8124 | NE 8724 |
| A 4340 | — | 4340 | X 4340 | A 4068 | NE 8547 | NE 8949 |
| A 4620 | A 4620 | 4620 | 4620 | A 4027 | NE 8024 | NE 8620 |
| A 4640 | — | 4640 | 4640 | A 4063 | NE 8339 | NE 8739 |
| A 4645 | — | — | — | A 4068 | NE 8447 | NE 8744 |
| 4650 | — | — | — | A 4068 | NE 8547 | NE 8949 |
| A 4820 | A 4821 | 4820 | 4820 | — | NE 8124 | NE 8724 |
| A 5045 | A 5045 | — | — | A 4063 | NE 8339 | |
| A 5120 | A 5120 | 5120 | 5120 | A 4027 | NE 8024 | |
| A 5130 | A 5130 | — | — | A 4037 | NE 8233 | |
| A 5140 | — | 5140 | 5140 | A 4063 | NE 8339 | |
| A 5145 | A 5145 | — | — | A 4068 | NE 8442 | |
| A 5150 | A 5152 | 5150 | 5150 | A 4068 | NE 8447 | |
| A 6120 | A 6120 | — | — | A 4027 | NE 8024 | NE 8620 |
| — | — | 6130 | — | A 4037 | NE 8233 | NE 8630 |
| WD 6140 | — | — | — | A 4063 | NE 8339 | NE 8739 |
| A 6145 | — | — | — | A 4068 | NE 8442 | NE 8744 |
| A 6150 | — | 6150 | 6150 | A 4068 | NE 8447 | NE 8749 |

# REDESIGNS OF SIMPLE STEELS

Even before emergency steel specifications were under way, engineers began changing their designs and production specifications so that plain carbon steels could be used in place of nickel, chrome-nickel, vanadium and other high alloy steels.

### LOCAL HARDENING PERMITS USE OF PLAIN STEEL

SHIFTING FORKS in the automotive transmissions made by Spicer Manufacturing Corporation had originally been made of plain carbon steels. But because the carbon steels warped in the heat-treating operations, S.A.E. 4615 and S.A.E. 3115 steels were adopted. When nickel and chromium became scarce and it was obvious that they would have to return to plain carbon steel, Spicer engineers made a careful study of ways and means by which the previously encountered difficulties with plain carbon steel might be avoided.

Now made of S.A.E. 1050 steel, the shifting forks are rough machined, oil-hardened to a point at which they are still machinable and are then finish machined. Only those surfaces of the forks where high-hardness is required for wear resistance are then local hardened by the Tocco induction heating process.

Here, a complete analysis of the problem showed that through hardening was not needed and that local hardening for wear resistance at the points required could be obtained by the Tocco process. The Tocco process, unknown at the time when the troublesome warping of the plain carbon steel forced the adoption of high-alloy steel, now made possible a return to low-carbon steel forks.

### SIMPLE STEELS FOR HEAVY-DUTY GEARS

TO REPLACE S.A.E. 4620, S.A.E. 6120 and S.A.E. 4320 steels, formerly used for gears, Spicer engineers decided on Amola steel, a carbon steel containing 0.25 percent molybdenum plus a trace of aluminum. This steel has heat-treating characteristics considerably superior to plain carbon steel in that the hardness produced is more uniform and there is no warping or distortion.

A machine tool builder is investigating the possibility of using silicon steels in place of S.A.E. 4615 for gears. It looks promising but test data are insufficient to draw definite conclusions.

For cast gears, the Falk Corporation some time ago developed a manganese-moly cast steel, trade named Molytelastic. This steel responds well to the usual annealing and normalizing treatment and can also be oil or water quenched and tempered for maximum physicals without warping or cracking.

For pinions formerly made of nickel steels, Falk uses Molydie, a low chrome-nickel-moly forging steel. For pinions up to 12 in. a high carbon grade is used which behaves similar to S.A.E. 4340 and usually is used in the normalized and tempered condition. For larger gears, a lower carbon Molydie steel is used and the gears are oil or water quenched and tempered.

In the design of one of their dividing heads, Kearney & Trecker changed from S.A.E. 3140 to S.A.E. X-1335 for the spindle of their Model K dividing head. Another manufacturer switched from S.A.E. 4615 for carburized gears and spindles to S.A.E. 1314 and finally to S.A.E. 1020 steel.

### HEAT-TREATING STEELS FOR HEAVY SECTIONS

FOR HEAVY SECTION MEMBERS heat-treated for high strength, a road machinery manufacturer had been using S.A.E. 4140, replaced it with S.A.E. 1340 and finally went to S.A.E. 1040. The only difficulties encountered were those attending heat-treatment, caused primarily by the large steel sections used. Heat-treating of heavy sections can often be improved by making the member hollow, thereby greatly increasing the quenching area and reducing the depth of penetration required for complete through hardening. Hollow-bored locomotive axles and crank pins are an example of this practice.

### CARBON VERSUS HIGH-ALLOY STEELS

PLAIN CARBON STEEL and high-alloy steel, both heat-treated to the same hardness, will in general have the same tensile strength, but the plain carbon steel requires more rapid cooling in the quenching to bring it to the same hardness as the alloy steel. This presents no difficulty when the sections are thin or only of medium thickness. In the case of heavy sections, the design might possibly be changed to make the section hollow, thereby increasing the speed of cooling and decreasing the distance from the innermost point to the surface. According to tests by General Motors, 1040 S.A.E. steel bars about ½ in. diameter cannot be hardened to more than about 50 Rockwell C. Amola 68 C in sections 1-in. diameter can be core hardened up to more than 60 Rockwell C. Steels containing only molybdenum and less than 1.00 percent manganese to give the desired hardness have been used in production by General Motors for more than two years.

### SUBSTITUTES FOR LOW-ALLOY MANGANESE STEEL

MAN-TAN, low-manganese high-strength steel in the as-rolled condition was formerly used by a road machinery manufacturer for bottom plates, side plates and lips of drag line shovels, where strength and toughness was required. To conserve manganese, plain carbon rolled steel structural plates are now being used; the thicknesses having been increased somewhat to compensate for the lower strength and toughness.

### SIMPLE STEELS FOR SHOCK RESISTANCE

PARTS SUBJECTED to heavy reciprocating loads in food machinery were formerly made of ¼ in. rods of S.A.E. 2330, heat-treated to 1,475-1,500 deg. F., quenched in oil and drawn at 800 deg. F. This gave the strength and toughness required for shock resistance. These parts are now made of S.A.E. X-1335, heat-treated to 1,500-1,550 deg. F., quenched in oil and drawn from 900 deg. F., thereby obtaining practically the same physicals. High strength bolts, formerly nickel alloy steel are now S.A.E. 1035 heat-treated, and to gain strength in the root section, national standard fine threads are used in place of national standard coarse threads.

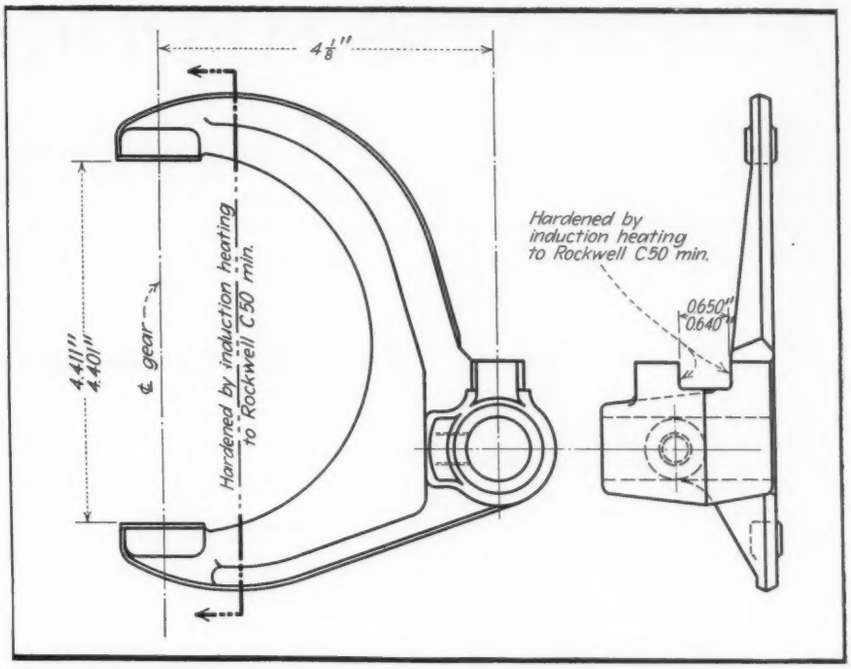
### SPECIFYING FORMS EASIER TO PRODUCE

MUCH HAS BEEN ACCOMPLISHED to help the steel situation by modifying designs so as to use steel in forms more readily

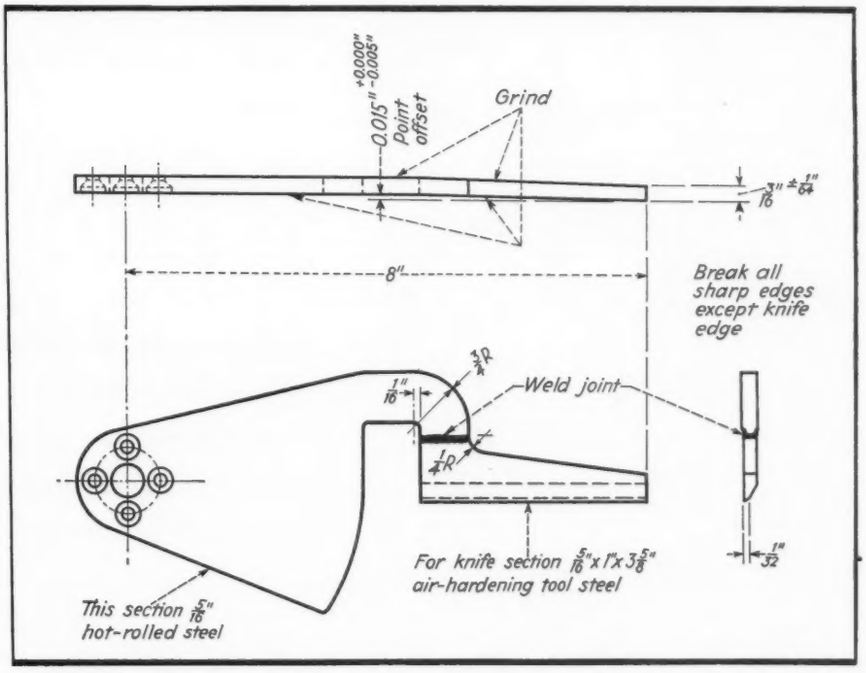
available. Rollers for heavy turntables, formerly drop forged are now cast by one manufacturer of road machinery. In place of rolled shapes, this company uses built-up welded assemblies of bars and plates. Narrow plates welded together are used instead of hard-to-obtain wide plates, a practice which is rapidly becoming general.

## WELDED ON CUTTING EDGE CONSERVES ALLOY STEEL

ANOTHER EFFECTIVE METHOD to conserve alloy steel is to make out of the alloy steel only the portion for which alloy steel is essential, the remainder being plain carbon steel. This is illustrated in the design of a shear blade for a paper cutter which, for simplicity in production, was originally designed as one piece of air-hardening tool steel, hardened, drawn, and ground. To conserve the high-grade alloy steel the shank is now cut from $\frac{5}{16}$ in. hot-rolled steel plate, to which is welded the tool steel cutting edge. Weld is made after hardening and drawing the blade. Finish machining, grinding both sides of blade, and sharpening of knife blade are final steps.

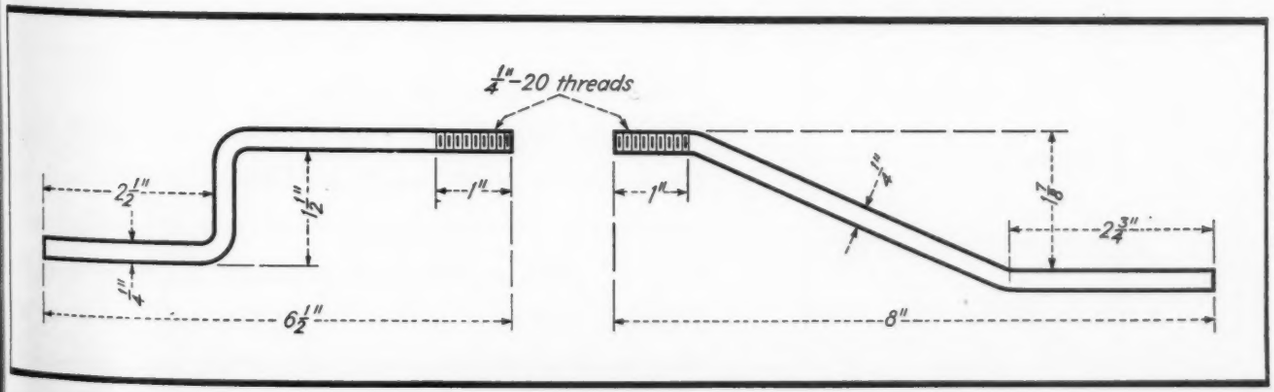



*Carbon steel warped when this fork was through-hardened and, therefore, high-alloy steel was used. But by specifying local hardening by the Tocco process, Spicer engineers made it possible to return to S.A.E. 1050 steel*




*Two-part shear blade with cutting edge of alloy steel welded to the carbon steel backing. Former design was a one-piece alloy steel cutter*

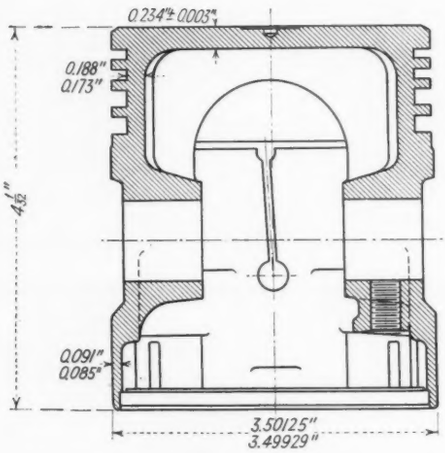
*These connecting rods on a food packaging machine were formerly of S.A.E. 2330 in order to withstand the high loads and impact to which they were subjected. They are now of S.A.E. X-1335 steel*



# ALTERNATES FOR LIGHT METALS

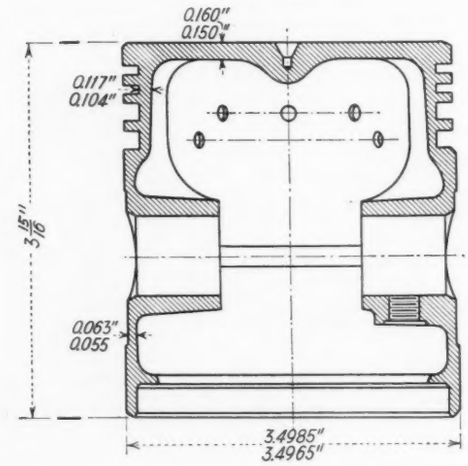
FIRST CONSIDERATION in any redesign problem where lightness appears to be the major consideration, is to determine whether lightness is an essential requirement or merely a convenience. Thus, there are the two extremes; aeronautical designs wherein lightness is absolutely essential, and cover plates for stationary engines wherein lightness is merely an incidental convenience feature. Between these two extremes there are innumerable applications. In this section are shown not only redesigns wherein lightness is highly important for the proper functioning of the product but also designs wherein the use of light weight metal was not essential.

## From Aluminum to Iron Pistons



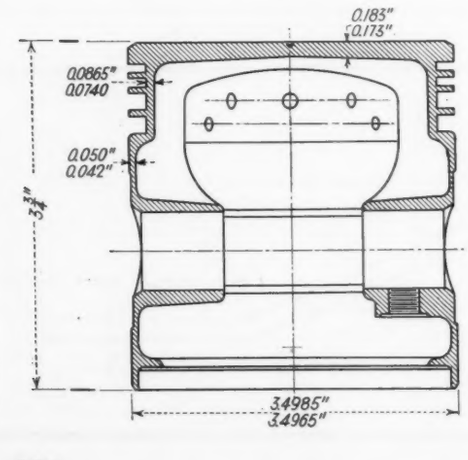

**ALUMINUM PISTON, WEIGHT 1 LB. 1.53 OZ.**

In one of the General Motors engines, the 3½ in. aluminum piston shown here had long been standard. While the wall sections of this piston were possibly 50 percent thicker than those of the original cast iron pistons, the lightness of aluminum made this piston by far the lightest; 1 lb.-1.53 oz. finished weight. Its surface was alumilited by the oxalic-sulphuric acid method.




**CAST IRON PISTON, 2 LB. 0.75 OZ.**

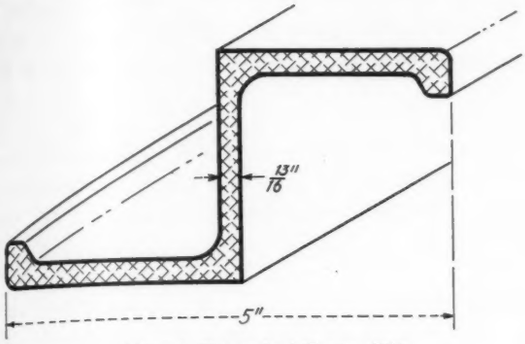
When aluminum had to be eliminated, the only immediate step feasible was to go back to the old cast iron pistons. They were of cast iron with a Brinell hardness of 187 to 229. Surface of the piston was tinned to 0.001 in. thickness.



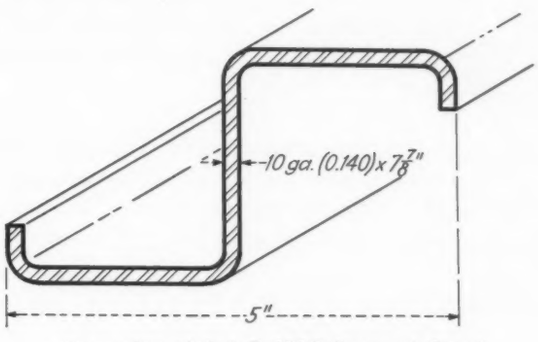

**ARMASTEEL PISTON, 1 LB. 11.2 OZ.**

A new design of pistons made of Armasteel was developed. These pistons were found satisfactory in tests and were immediately adopted. Armasteel is a short-annealed malleable iron which, as used in this piston, has a tensile strength of 61,000 lb. per sq. in. and a Brinell hardness of 170 to 207. The surface of the piston is tinned to 0.001 in. thickness.

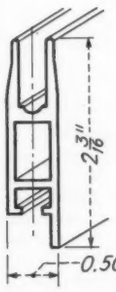
## COMPARABLE EXTRUDED ALUMINUM AND FORMED SHEET STEEL SECTIONS



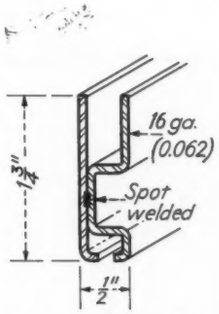

Nicral Extruded Cross Sill
*2.185 lb. per ft.*



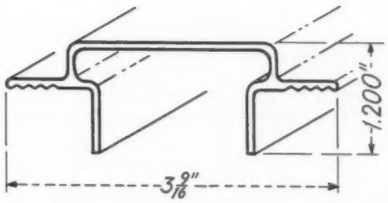

Cross Sill of S.A.E. 1020 Pressed Steel
*3.74 lb. per ft.*



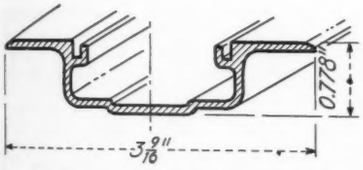

Raise Sash Bottom Rail of Extruded Nicral
*0.385 lb. per ft.*



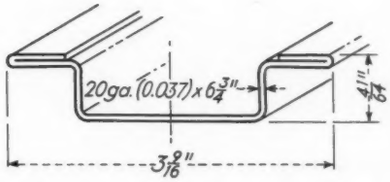

Raise Sash Bottom Rail of Cadmium-Plated Steel
*1 lb. per ft.*



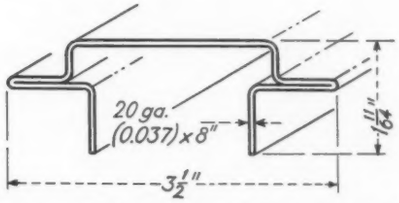

Outside Sash Guide of Extruded Nicral
*0.665 lb. per ft.*




Inside Sash Guide of Extruded Nicral
*0.548 lb. per ft.*




Inside Sash Guide of Cadmium-Plated Steel Plate
*0.83 lb. per ft.*




Outside Sash Guide of Cadmium-Plated Steel Plate
*1 lb. per ft.*

# All-Steel Buses Only Slightly Heavier

In common with all other bus builders, Twin Coach Company of Kent, Ohio, found it necessary to eliminate aluminum from their designs. Aluminum sheet had been used for sheathing and practically all the framing was of extruded aluminum sections. For the body covering, Twin Coach changed from sheet aluminum to cold rolled steel auto body stock. By taking advantage of the greater strength and stiffness of steel and using pressed-in stiffening ribs it was possible to decrease the sheet thicknesses and thereby partially compensate for the greater unit weight of steel.

Stamped-in stiffening ribs in the steel outer sheathing are spaced about 7 in. apart in both the side and top panels. These pressed-in ribs run lengthwise and by proper positioning they have enhanced the appearance of the bus by accentuating the streamlining.

In the old design a triple beaded reinforcement of pressed aluminum sheet extended as a narrow band from wheel housing to wheel housing along the side of the bus at about the level of the axles. An aluminum die casting was used at each end of the stamping to trim the ends. In the new design this construction is entirely of pressed steel with a separate stamping at each end for trimming. The aluminum extruded sections, forty of them, used in the framing of the old design of bus have all been replaced by formed sections of hot rolled steel sheet. Some typical sections are shown above.

# Welded Steel Lighter Than Aluminum Castings

**LIGHT-WEIGHT VIBRATING STRUCTURAL ASSEMBLY,** used on printing presses, was formerly made by bolting together aluminum alloy sand cast parts to form two frames which were clamped to a steel tube brace. To conserve aluminum, with an ingenious new design, the R. Hoe & Company now fabricate equivalent structures by welding. A complete unit consisting of parts cut from steel tubes, bar stock and plates is thus formed.

**CHIEF DESIGN CONSIDERATION** was to avoid high inertia effects since when the printing press is operating the structural assemblies oscillate or vibrate through a 3 in. stroke at 380 cycles per min. Therefore, lightness in weight of the moving structure was essential. Other loads on the part do not impose the need for any great structural strength or rigidity.

**WELDED STRUCTURAL ASSEMBLY DESIGN** not only conserves aluminum but also develops less inertia effects, since the weight is about 75 percent as much as the assembly that is made up of castings and a steel tube. The aluminum castings used in the former assembly weighed 62 lb. in the rough. Cost of materials, as well as manufacturing costs, are less for the new design.

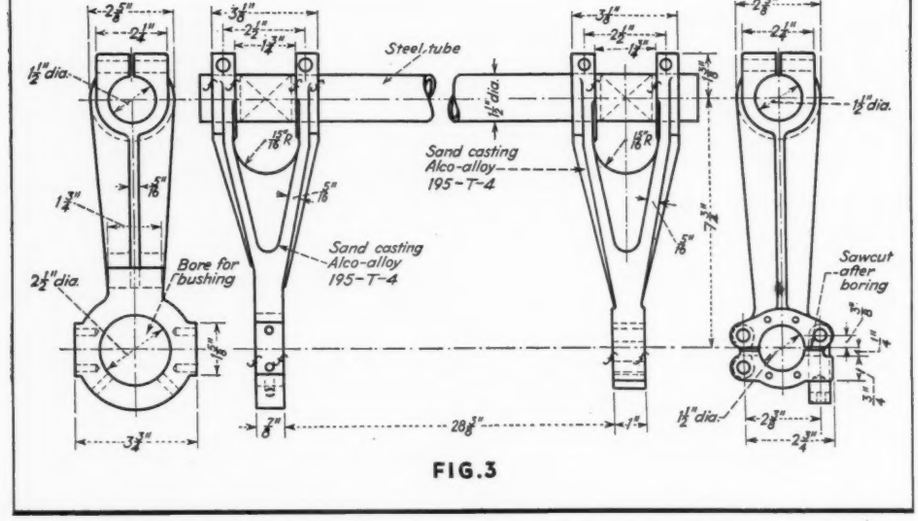



FIG. 3

*Figs. 1 and 2—In the old design, shown in Fig. 1, overall cost was reduced by casting side frames C and D from the same pattern then, after machining, bolting to the side frames the brackets E and F which are not identical. A difficult molding operation was also avoided by using a separate tubular member instead of a cast integral brace piece to join the two side frames. Brackets G and H were also made as separate pieces in order to avoid the necessity for complicated molding operations. Fig. 2—The structure as redesigned, to conserve aluminum, for fabrication by welding together parts cut from steel tubes, round and flat bar stock.*

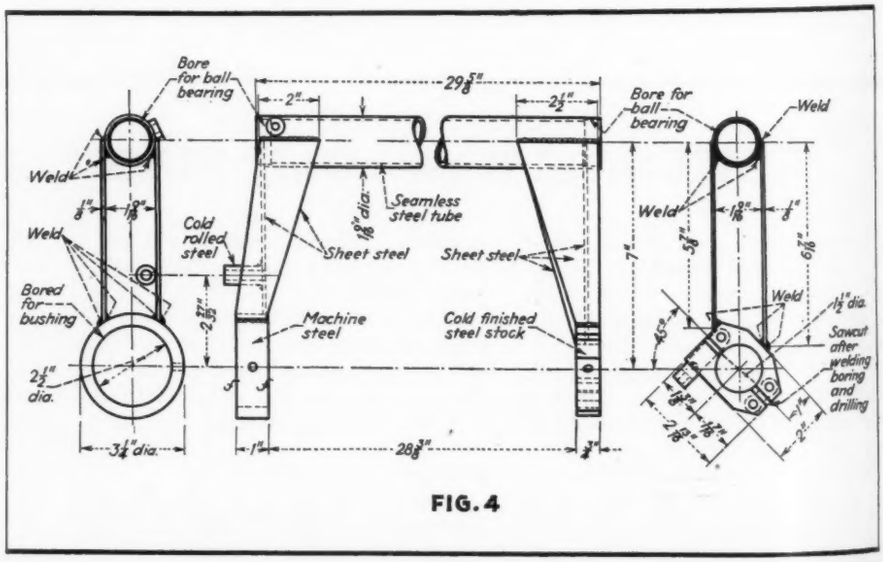



FIG. 4

*Figs. 3 and 4—Another smaller assembly is shown in Fig. 3, this consisted of two aluminum sand castings clamped to a steel tube. The aluminum castings weighed about 5 lb. To conserve aluminum this assembly was also redesigned, as shown in Fig. 4, for fabrication by welding together parts cut from steel tubing, steel plate and bar stock. The weights for the two designs are about the same. The cost of materials for the welded assembly are less than for the aluminum castings and steel tube assembly, however, manufacturing costs for the aluminum construction are less when more than three assemblies are made, because of distribution of pattern cost.*

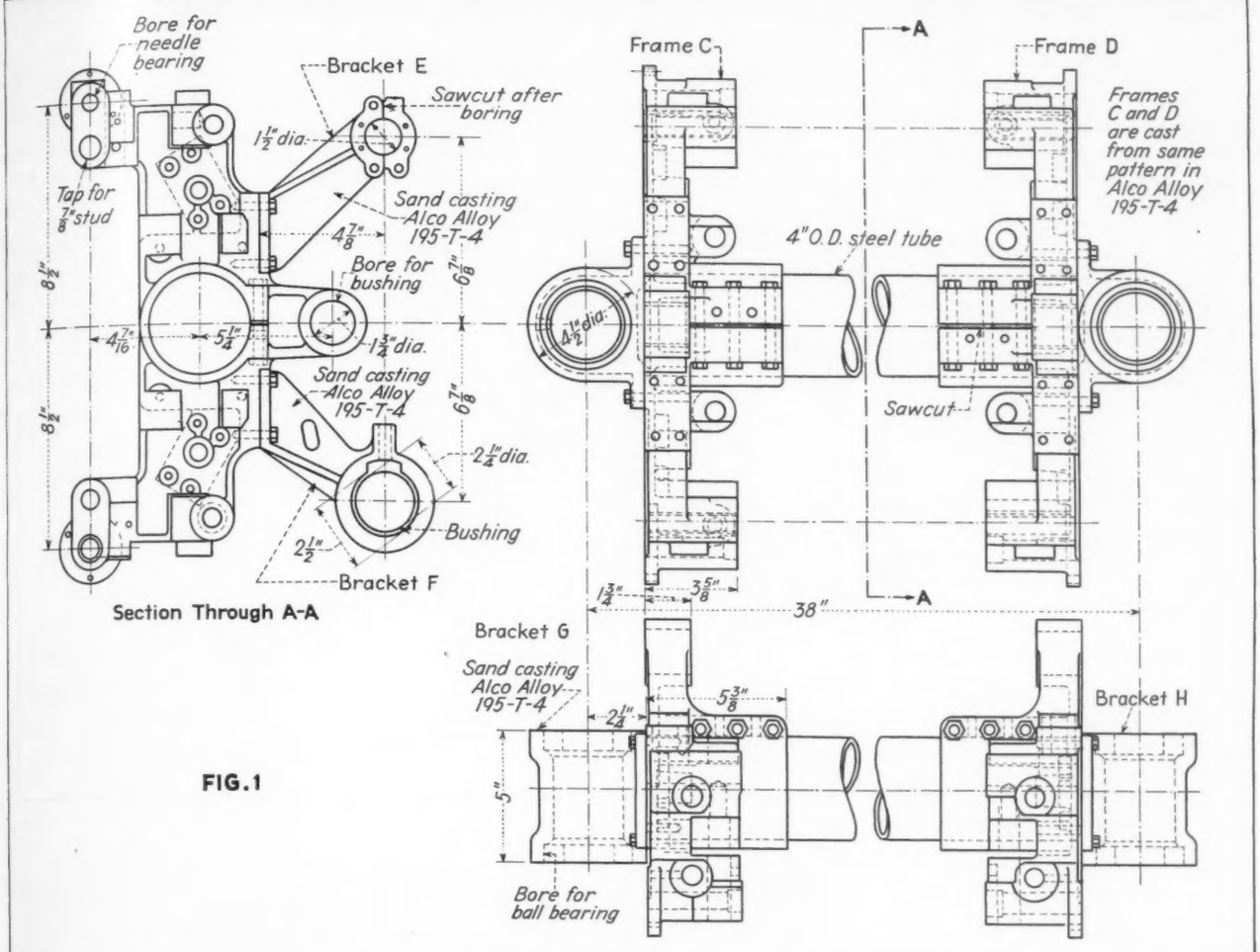

Bore for needle bearing
Bracket E
Sawcut after boring
1½" dia.
Tap for ⅞" stud
Sand casting Alco Alloy 195-T-4
4⅞"
Bore for bushing
6⅞"
8½"
4 7/16"
5¼"
1¾" dia.
Sand casting Alco Alloy 195-T-4
6⅞"
8½"
2¼" dia.
Bushing
2½"
Bracket F
Section Through A-A
Frame C
A
Frame D
Frames C and D are cast from same pattern in Alco Alloy 195-T-4
4" O.D. steel tube
4½" dia.
Sawcut
1¾"
3⅝"
38"
A
Bracket G
Sand casting Alco Alloy 195-T-4
2¼"
5⅜"
Bracket H
5"
Bore for ball bearing

FIG. 1

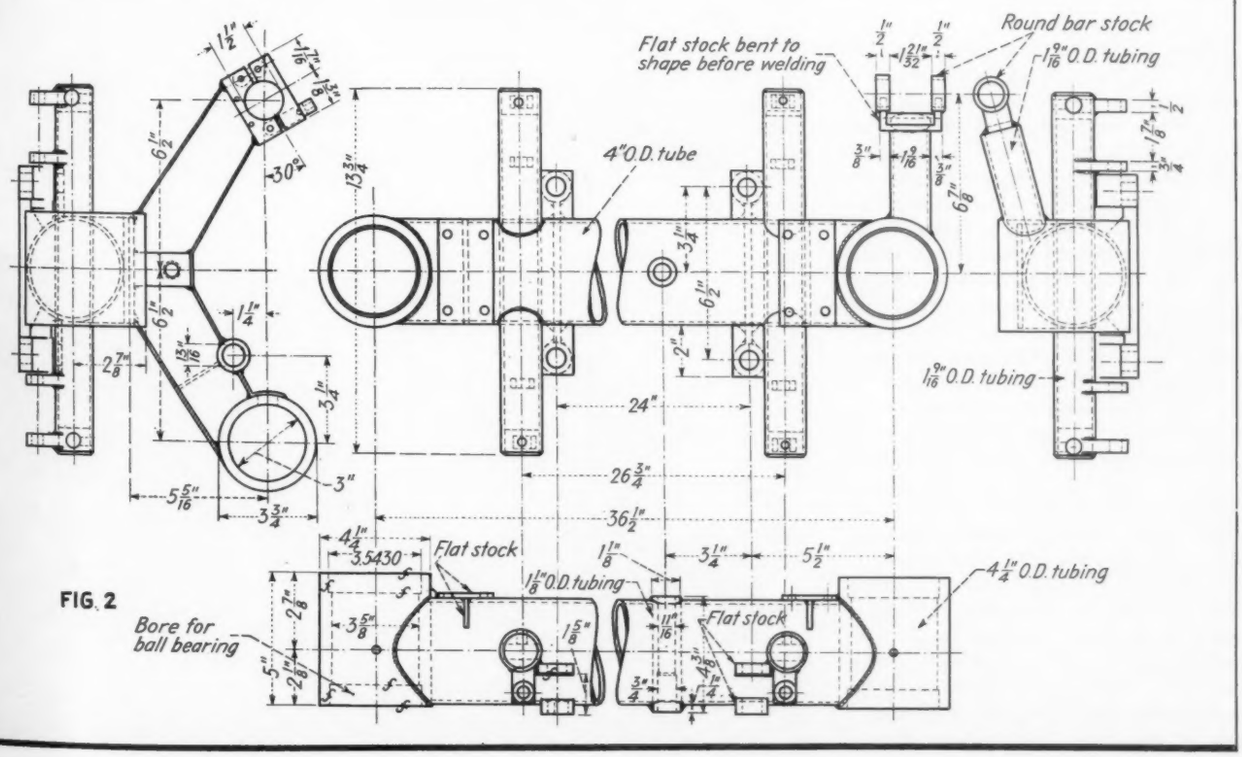
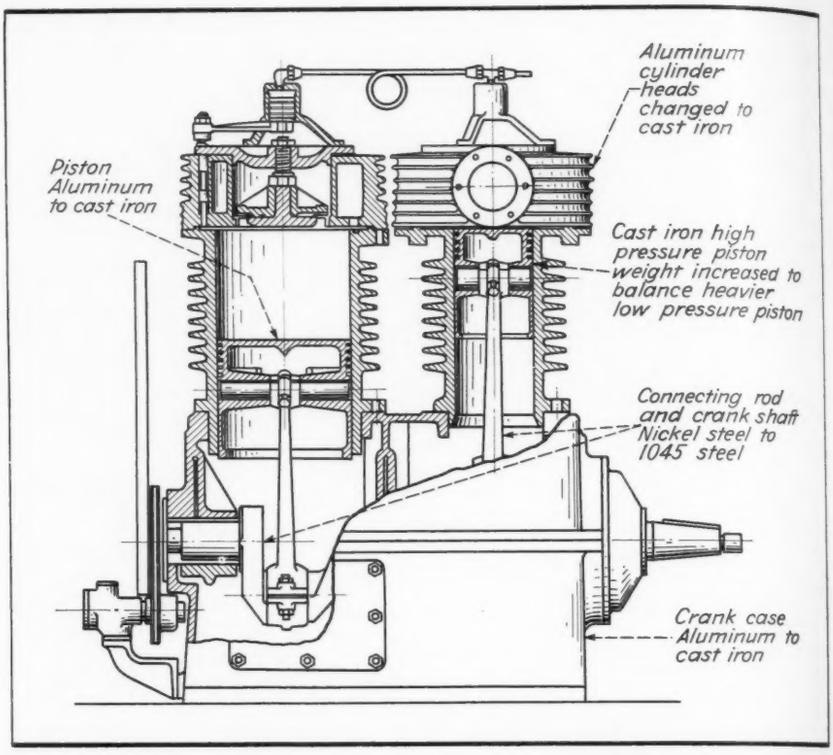

1½"
1 1/16"
1 9/16"
6½"
30°
Flat stock bent to shape before welding
½"
½"
1 21/32"
Round bar stock
1 9/16" O.D. tubing
4" O.D. tube
13¾"
⅜"
1 9/16"
⅜"
6⅞"
1⅞"
½"
¾"
3¼"
6½"
1¼"
2⅞"
10/16"
3¼"
2"
1 9/16" O.D. tubing
24"
3"
5 5/16"
¾"
26¾"
36½"
4¼"
3.5430
Flat stock
1⅛"
3¼"
5½"
4¼" O.D. tubing
1⅛" O.D. tubing
Flat stock
2⅞"
3⅝"
1⅝"
11/16"
5"
2⅛"
Bore for ball bearing

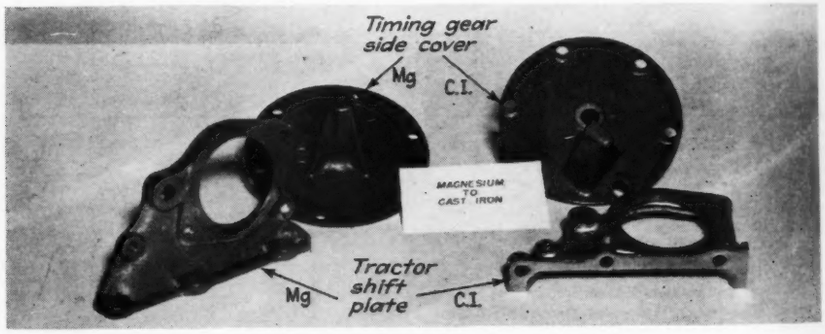
FIG. 2

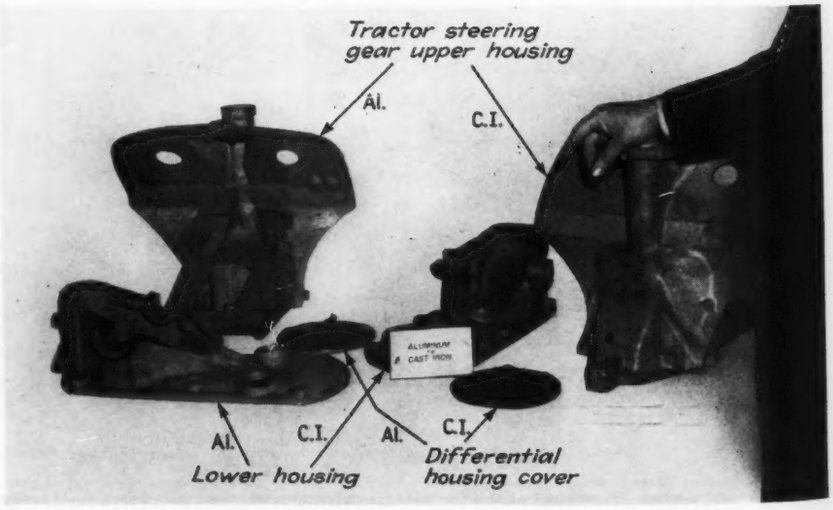
# Redesigns to Save Aluminum and Magnesium

**Aluminum saving** is not confined to non-defense equipment. Davey Compressor Company now producing air compressors 100 percent for defense industries and defense work, has replaced air-cooled aluminum cylinder heads, a feature of its compressors, as well as aluminum crankcases, pistons, and manifolds (not shown) with cast iron parts, as indicated here. Dimensional design changes were required only in the cast iron high-pressure piston, which had to be made somewhat heavier to balance the additional weight in the low-pressure piston after it had been changed to cast iron. Differences in casting methods and shrink accounted for insignificant changes. Increase in weight as a result of these changes is about 125 lb. for the small compressor, more than 80 percent of the increased weight being in the crankcase.

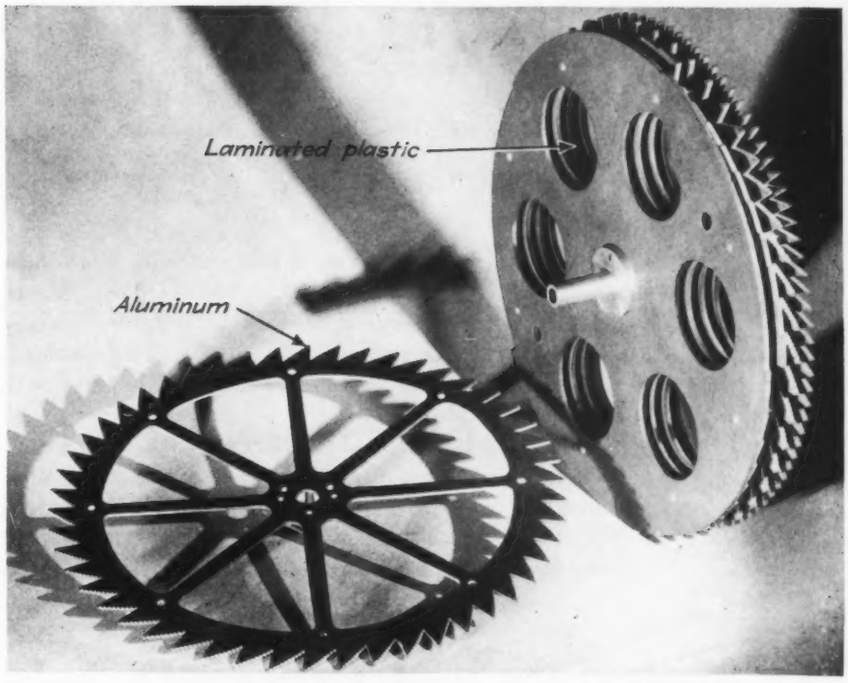

Aluminum cylinder heads changed to cast iron
Piston Aluminum to cast iron
Cast iron high pressure piston weight increased to balance heavier low pressure piston
Connecting rod and crank shaft Nickel steel to 1045 steel
Crank case Aluminum to cast iron

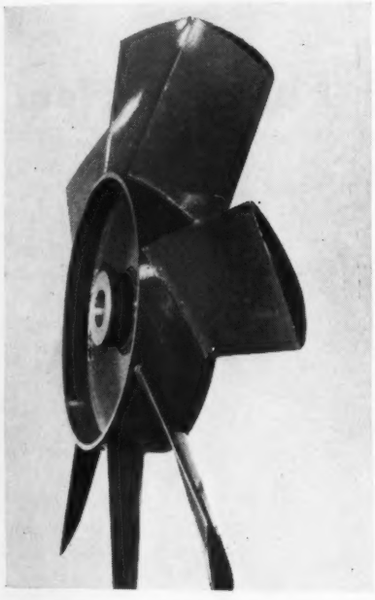
**Timing gear** side cover and the power take-off shift plate of Ford tractors have been made of magnesium because of its ease in handling, good machinability, and light weight. The magnesium alloy contained 6 percent aluminum, 3 percent zinc, the balance magnesium. With strategic materials scarce, the Ford company turned to cast iron, and now a cast iron cover weighing 2.40 lb. replaces a magnesium cover that weighed 0.56 lb., and a cast iron shift plate weighing 3.20 lb. replaces a magnesium plate that weighed 0.75 lb. The low-strength requirements of these parts are adequately met by cast iron and magnesium. The Ford Motor Company used cast iron also to replace aluminum previously used for many of their tractor parts. The aluminum alloy previously used had contained 7 percent copper, 1.25 percent silicon, and the balance aluminum. It also had been used not so much because of its lightness but its good machinability. Iron castings proved a satisfactory substitute although they are 2½ times heavier than the aluminum castings.



**Fast starts** and stops at high operating speeds make light weight with high strength the primary requirements for this printer disk of Kron precision industrial scales. Good machinability to close tolerances is also required. The four disks formerly were Duralumin, each 0.093 in. thick and 11 1/8 in. dia. Alternate material, selected after extensive tests, is linen-base laminated phenolic. Disks are punched from sheets 0.125 in. thick. Notches are shaved after punching. Total weight of the new assembled printer disk is only one-half that of aluminum unit.



**Axial type** propeller fans for high static pressure operation were made of cast aluminum by International Engineering, Inc., as long as aluminum was plentiful. Experimental operation of a fabricated steel plate type fan for over two years enabled a quick shift to light plate and sheet without sacrificing fan efficiency. Salient feature of this all-welded fan is its three-part hollow blade which is shaped for proper air foil section with pitch varying from hub to tip. All blade parts, front, back, and end, are die formed. Fan diameters have ranged from 20 to 50 in. but can be made larger. First step in assembly is to roll the rim around the disk, which is 1/4 to 1/2 in. thick depending on fan size, and weld it on. The hub is then welded in place and machined. Blades are assembled by welding and then welded in place on rim with the aid of jigs.

---

RAPID RECIPROCATING MOTION of the pusher plate on a package carrier mechanism necessitated use of as light a material as possible to reduce noise, vibration, and shock loads. Hence aluminum was originally selected. The part is now made to the same dimensions out of sheet steel of the same thickness. Requirements of strength, stiffness, and the head dimensions of flat-head mounting screws made it impossible to use thinner gage steel without a complete redesign.

CARTON STOP PLATE for packaging machine was made from sheet aluminum 1/8 in. thick. Light-weight and stiffness are other desirable qualities for this design, hence previous use of aluminum. When redesigning for cold rolled steel, sheet thickness was reduced to 1/8 in. Thickness of steel was determined on basis of fatigue strength at section through neck. Milling operations on bevels have also been eliminated because bevels are unnecessary with thinner material.

PORTABLE or semi-portable power tools that owe their portability to extensive use of aluminum were seriously handicapped by the necessity of redesigning in cast iron. The rear pedestal for a semi-portable pipe threader, along with the base, gear case, and guard, when changed from aluminum to cast iron, added 150 or more pounds to a 390 lb. threader. This aluminum part, like others on this threader, is nearly duplicated in cast iron, the changes made being those required by the difference in shrinkage. A slightly larger bushing in one instance made even this change in dimensions unnecessary.

WHEN SWITCHING from aluminum or magnesium to steel, the weight of the finished product will not necessarily be increased by the difference in the weights of the aluminum and steel part. Appreciable reduction in the weight of associated parts can often be made thereby offsetting the increased weight of the steel part.

As an example of the reduction in weight of associated parts, an instrument manufacturer changed his instrument cases and panels from aluminum to steel. Because of the higher strength and stiffness of steel, the wall thicknesses of the case were reduced from 0.65 in. to 0.050 in., thereby reducing the volume of metal 23 percent. Similarly the panel thickness was reduced from 1/4 in. to 3/16 in., a reduction of 25 percent.

The smaller volume of steel, roughly 25 percent, compensated partly for the greater density of steel which is roughly three times that of aluminum. However, the thinner walls and panel thickness permitted shorter screws to be used and also shorter extension shafts from the knobs to the elements controlled.

When using thin sheet steel, maximum protection against rusting should be provided so that it will not be necessary to use extra thickness to compensate for corrosion.

# METHODS TO AVOID CORROSION

Examples of how engineers and designers are obtaining corrosion-resistant properties plus appearance value in their products through redesign for use of available materials and by specifying:

(1) Organic coatings on carbon steel

(2) Porcelain vitreous enamel on stampings and castings

(3) Glass for floats, springs and mechanical parts

(4) Molded porcelain where both dielectric strength and corrosion resistance are required

(5) Plastics such as Saran to replace brass and copper tubes

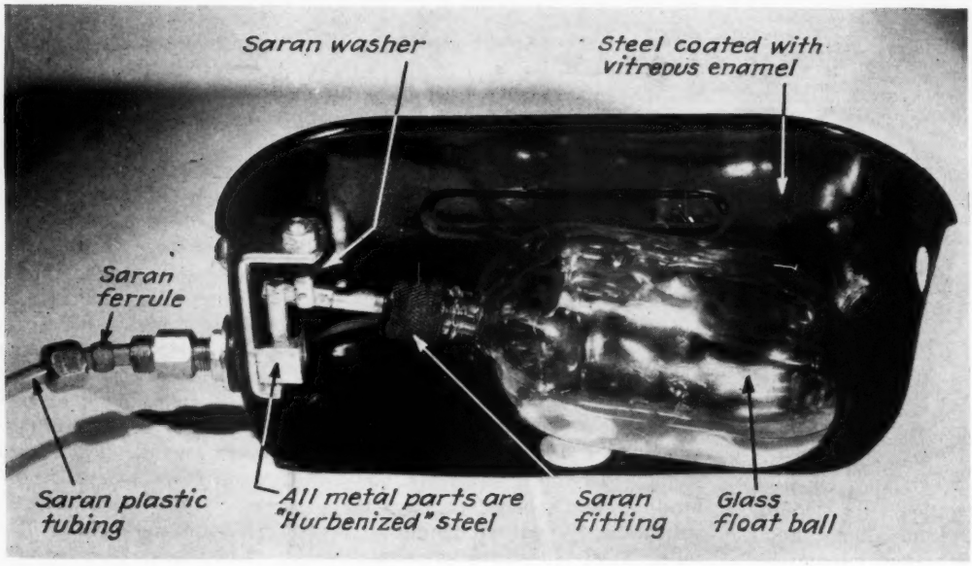
(6) High-silicon case on steel produced by heat-treatment as in the Ihrigizing process

(7) Thin lead coatings produced by dipping as by the Hurbenium process

(8) Chemical surface treatments such as Bonderizing, Parkerizing, Black Magic, Jetal and others

(9) Silver plating or cladding on base metals for corrosion resistance

## New Materials and Processes Solved This Problem




**Tank and valve assembly** of the humidifier manufactured by the J. L. Skuttle Company was formerly made almost entirely of copper and brass. These metals have now been eliminated from this assembly. The copper tank has been replaced by a steel tank coated with vitreous enamel, the copper float ball has been replaced by a glass float ball and brass nuts and washers have been replaced by Saran plastic units. A special Saran threaded fitting connects the float ball to the valve arm. For the outside tank connection, a Saran plastic ferrule has replaced the former brass ferrule. Brass brackets and adapters have been replaced by steel units coated with Hurbenium, which is also produced by this company.

Saran plastic tubing, used here in place of copper tubing, is manufactured by Skuttle and can be had in many sizes and colors. As used above it is pale yellow and transparent, tough and flexible. Hand tightening of the cap over the ferrule will seal against pressures of more than 50 lb. per sq. in.

The Saran fitting and washer, as well as the invisible bottle plug, are black and opaque. The fitting has a bottle cap thread molded integrally; the other threads are tapped.

Hurbenium is the trade name given to one of the alloys produced by the "Hurd Process". In this patented process, the best grade of commercial lead is heated for several hours by special laboratory methods in the presence of purifying agents. The name "Hurdon" is applied to the product of this refining method. Hurbenium "B" is composed of 91 percent Hurdon, 8 percent pure tin and 1 percent bismuth. It is a silvery white metal which cannot be oxidized or corroded under almost any conditions. Hurbenium is applied by hot-dipping at a temperature of 700 deg. F. The result is a non-porous coating, less than 0.002 in. thick, which penetrates into the metal and is sufficiently elastic so that it does not crackle or peel. Bending tests, acid tests, and salt water tests are said to show no damage to the coating.

Threaded parts, coated with Hurbenium, do not require retapping and can be screwed together to form a tight leakage proof joint.

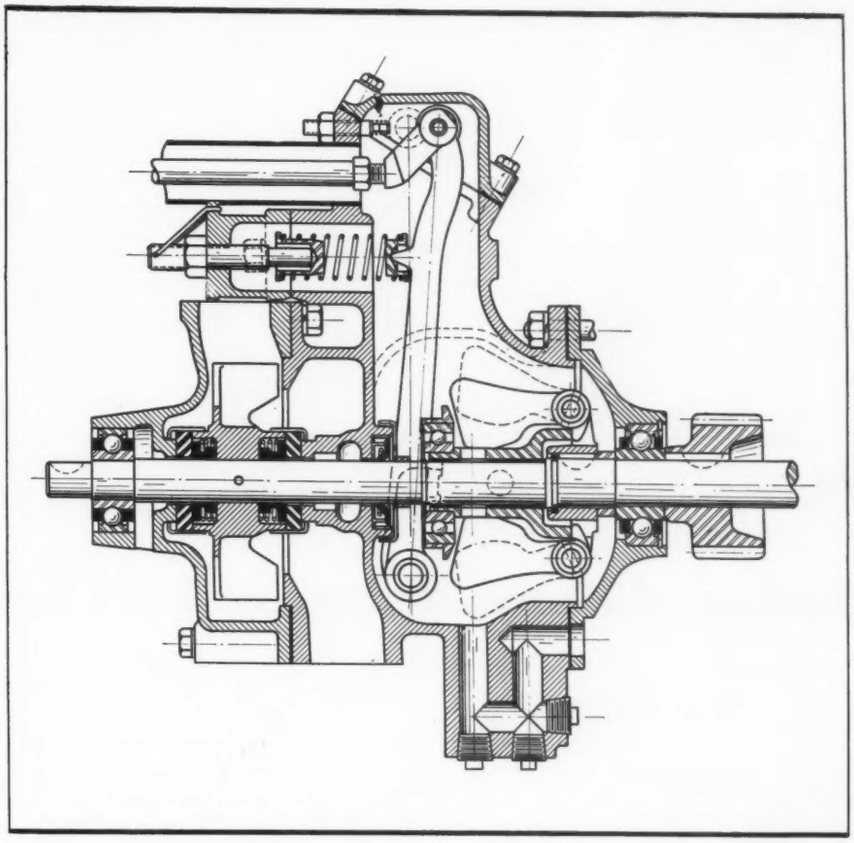
It is claimed that a Hurbenium coating results in a surface about 1/5th to 1/4th the weight of galvanizing, and about 1/8th to 1/9th the thickness of galvanizing. Hurbenium is said to be so fluid that 1 lb. of the metal will cover 4 or 5 times the surface covered by 1 lb. of spelter.

By applying any manufacturer's prescribed surface primer coating to Hurbenium coatings, paints and lacquers may be made to adhere permanently, withstanding even severe bending. The makers of Hurbenium claim that nickel and chromium plating may also be deposited successfully over this lead alloy coating.

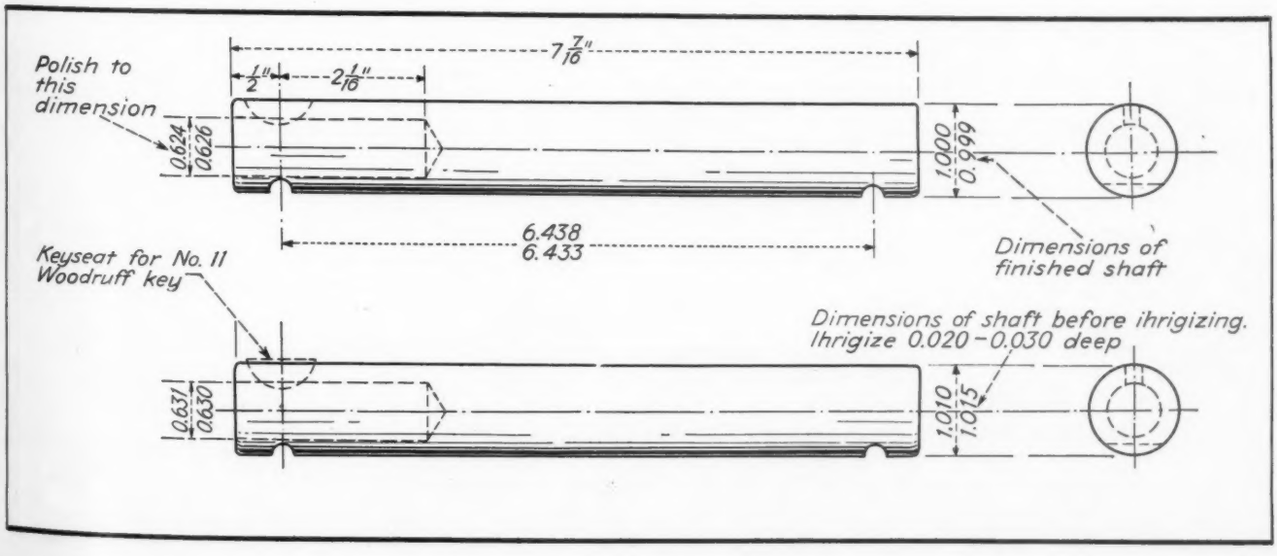
*Saran is a new plastic developed by Dow Chemical Company. A detailed description of it will be given in May.*

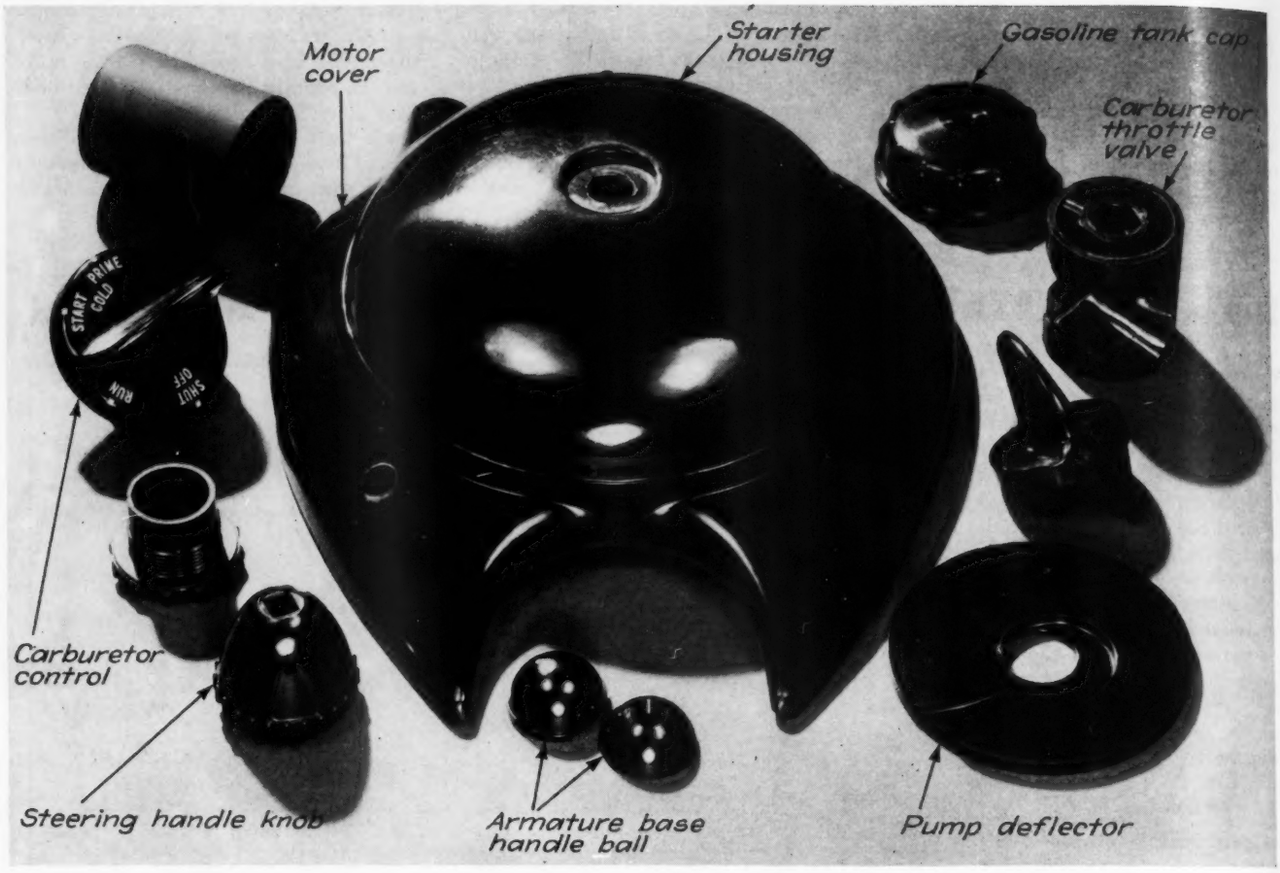
# Ihrigizing Makes Pump Shaft Corrosion Resistant

**Water pump shafts** on Waukesha engines formerly Monel or stainless to resist corrosive action of fresh or salt water are now made of S.A.E. 1020 steel, Ihrigized to resist corrosion. After eight years of test in service, the Ihrigized S.A.E. 1020 steel shafts were found to be just as corrosion resistant as the Monel or stainless shafts. Cost is about one-fifth that of stainless. To Ihrigize, the part is packed in a silicon-rich material, heated to about 900 deg. F., producing a case of 14 percent silicon. Depth of penetration increases with the time in the furnace and may ⅟₈ in. thick.



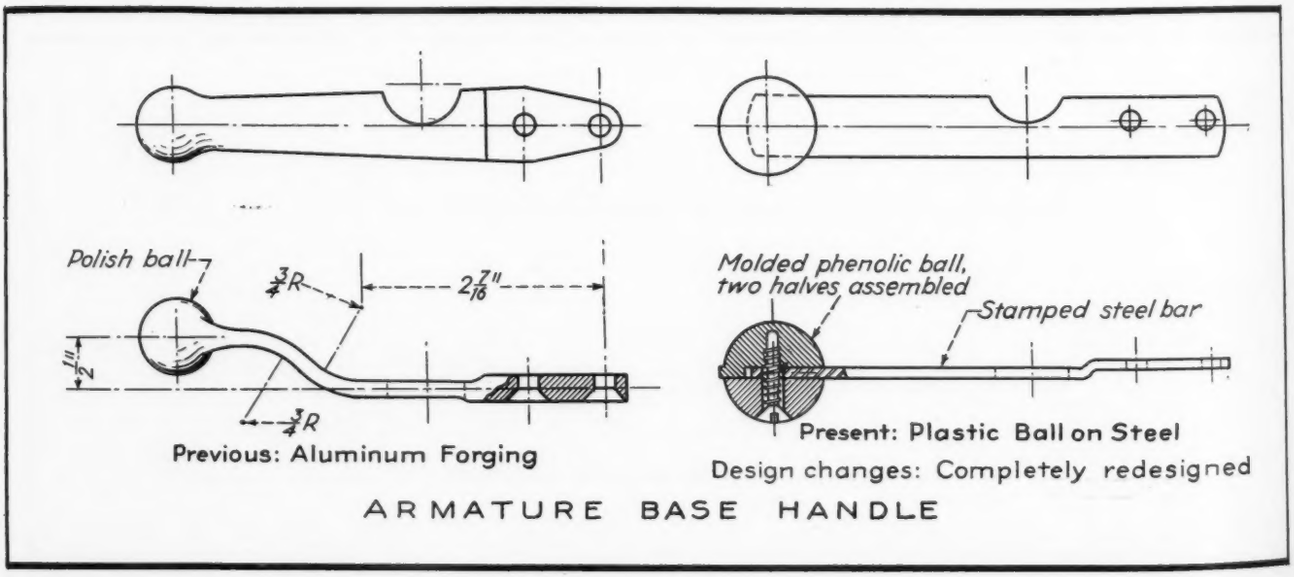
**Insignificantly slight** dimensional changes occur during Ihrigizing. All machining except threading should be done before Ihrigizing. Subsequent grinding is required only for smooth finish and dimensions that must be accurate to the order of 0.001 in. Silicon penetration through the tips of threads makes tips brittle, therefore portions to be threaded are left blank, the case turned off after Ihrigizing and the thread is then cut. The high-silicon steel case is appreciably harder than carbon steel.



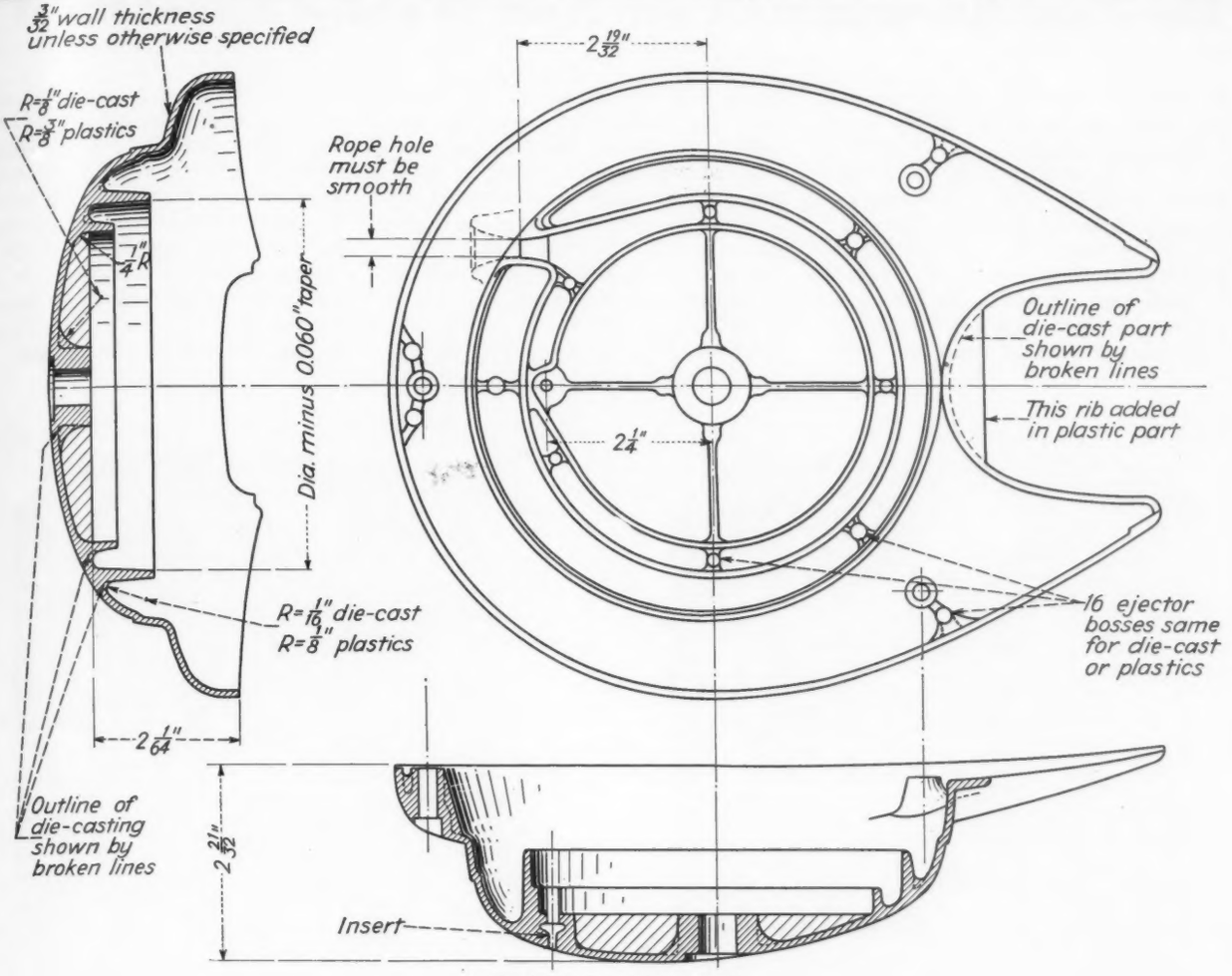



# Outboard Motor Redesigned to Eliminate Aluminum

OUTBOARD MOTORS, where good resistance to severe electrolytic corrosion from salt and fresh water, light weight, good appearance, machinability and strength are salient requirements of the materials used have in the past been made chiefly of aluminum. When aluminum shortage struck, Evinrude Motors engineers were completing extensive study of plastics, and confidently went from aluminum to molded phenolics with cellulose filler for all parts. None of the parts illustrated are in hard mechanical service. Section thicknesses and dimensions were kept the same for most parts; some required considerable redesign. High gloss of plastic finish and the sharp contrast between wiped-in white lettering and the black plastic, improved the appearance of the parts considerably.

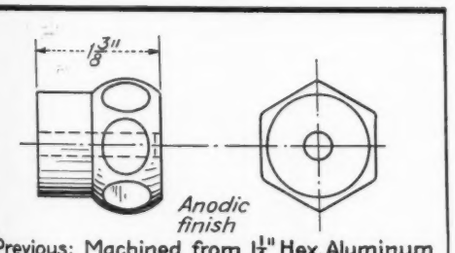



ARMATURE BASE HANDLE

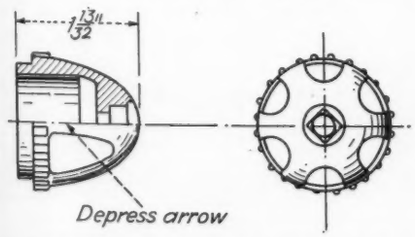



STARTER HOUSING

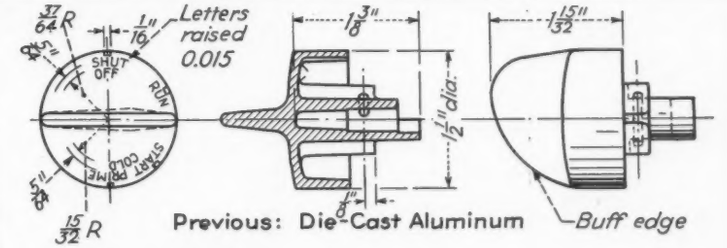
Previous: Die-Cast Aluminum; Present: Molded Phenolic Resin
Design changes: Larger fillets; some ribs thickened; slightly greater mold relief tapers in plastic part; wall thickness remains same
*Note: Appearance is improved*



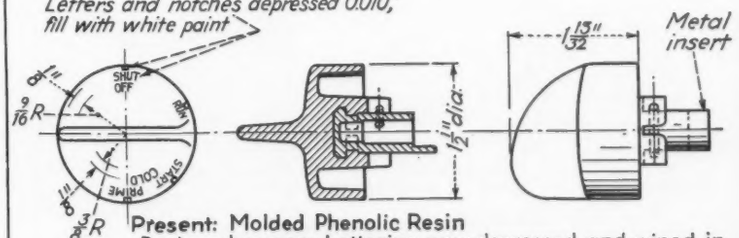

Previous: Machined from 1 1/4" Hex. Aluminum




Present: Molded Phenolic Resin
Design changes: Completely redesigned
STEERING HANDLE KNOB



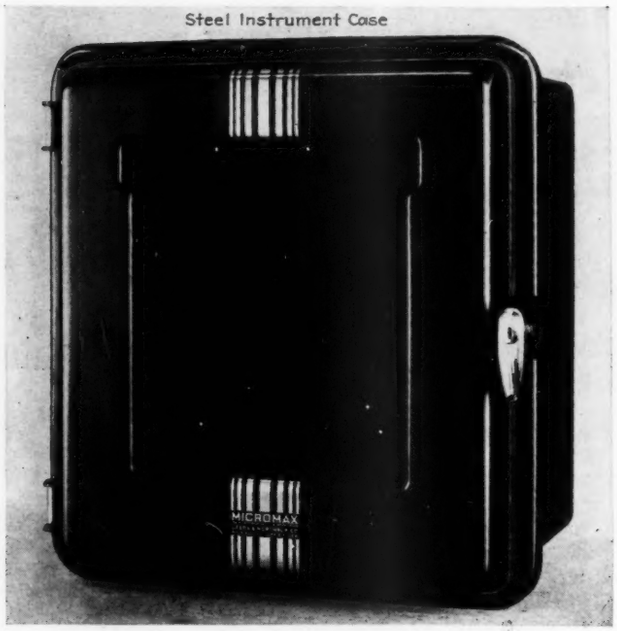

Previous: Die-Cast Aluminum

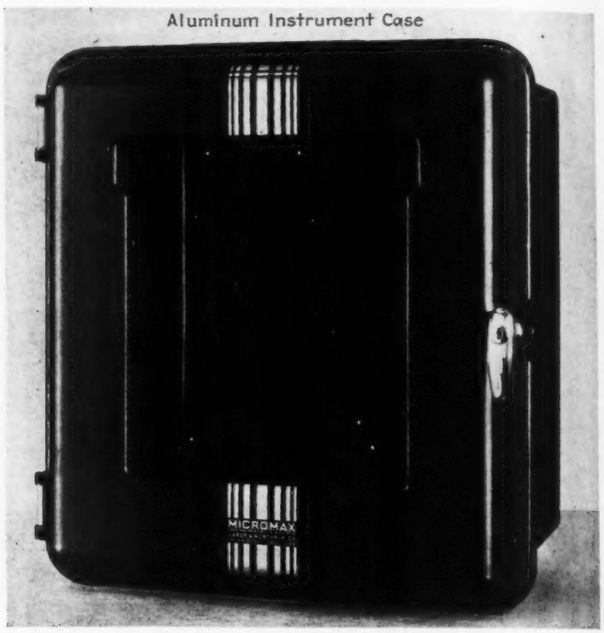



Present: Molded Phenolic Resin
Design changes: Lettering now depressed and wiped in with white; insert added
CARBURETOR CONTROL KNOB

# Die-Cast Aluminum Case Now Welded Sheet Steel

HOUSING for recording instrument was redesigned by the Leeds & Northrup Company for fabrication in steel, thus saving 24 lb. of aluminum per instrument and case assembly. The change in design was made without the necessity of any redesign in the instrument proper. Line drawings of door and case as made from aluminum base alloy die-castings are shown in Fig. 1. Equivalent steel parts as redesigned are shown in Fig. 2. The door is blanked and drawn from sheet steel. Hinge parts are spot welded and riveted. The lock parts are attached with screws. The three main pieces of the case are arc-welded in a jig to assure accuracy in register and alignment. The sides, top and bottom of the case are formed from one sheet with an arc-welded butt joint across the center of the bottom. The flange ring, a one-piece stamping, is arc-welded to the front of the case. In order to reduce scrap in manufacturing the steel case is designed so that the blank stamped from the center of the flange ring is used ready-cut for the back of the case. The steel door and case weigh only 15 lb. more than the aluminum die-cast case and door. For appearance both designs are finished with black lacquer; for corrosion resistance the steel case is Bonderized before lacquering.



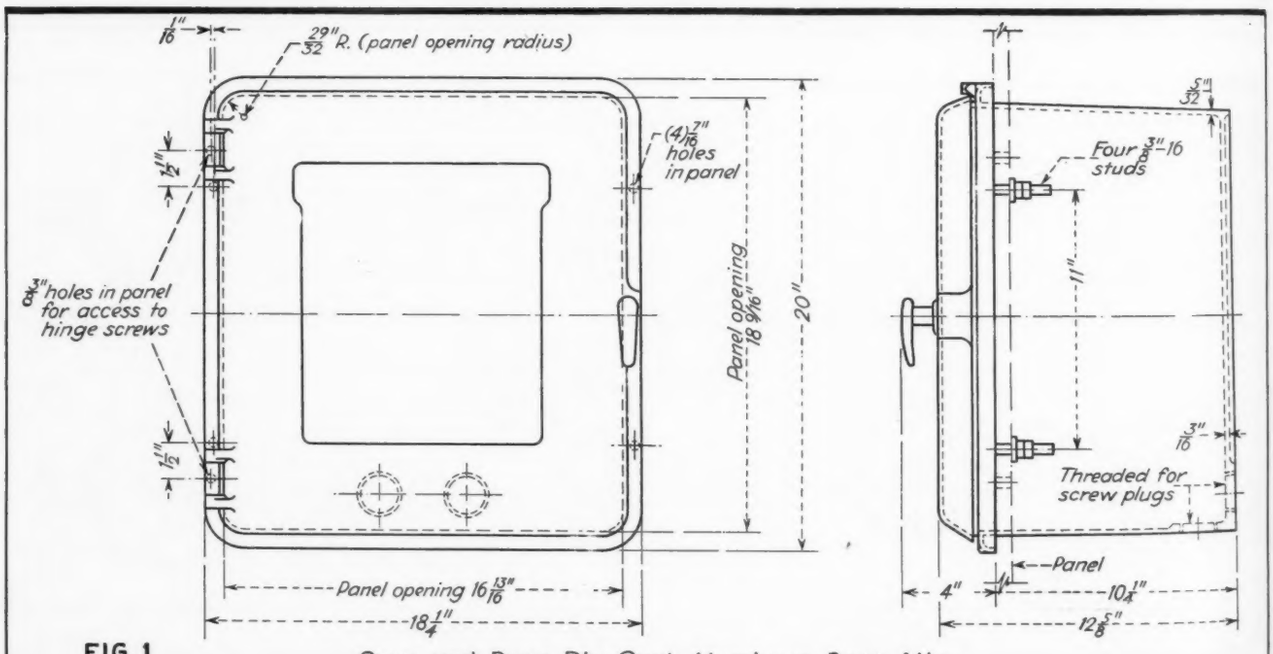




FIG. 1 Case and Door Die-Cast Aluminum Base Alloy

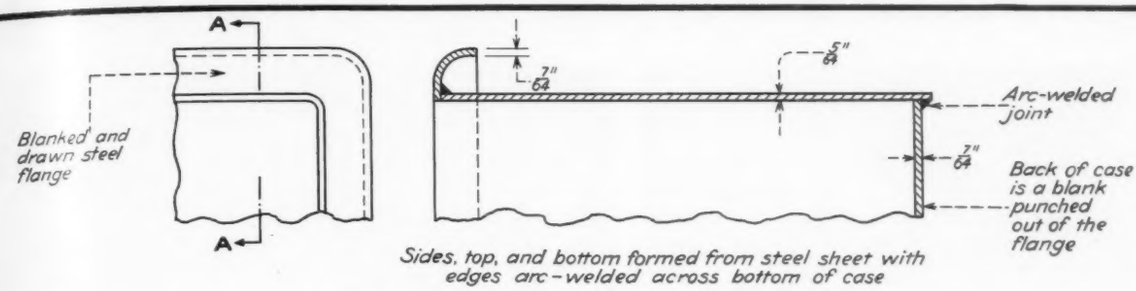
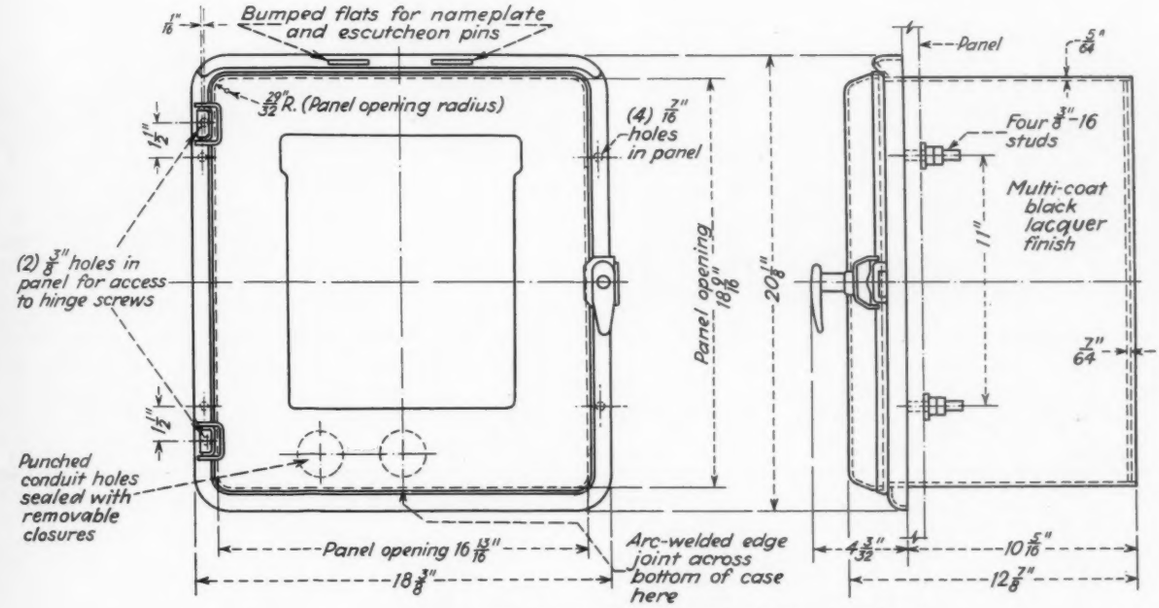

A
A
Blanked and drawn steel flange
7/64"
5/64"
Arc-welded joint
7/64"
Back of case is a blank punched out of the flange
Sides, top, and bottom formed from steel sheet with edges arc-welded across bottom of case

FIG.2 Detail and Section Near Corner of Steel Case



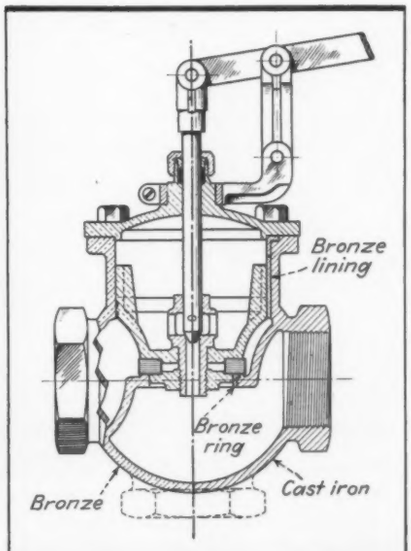

Case and Door Fabricated of Sheet Steel

# Material Change Saves Copper, Tin, Zinc

AIR-SUPPLY BRACKET CASTINGS in the pneumatic control instruments of the Brown Instrument Company were formerly of bronze. Corrosion resistance is an important requirement. Moisture in the control air might form rust or scale in the bracket passages, which would interfere with the operation of the system. Hence bronze was used. Several materials were considered as possible substitutes. Antimony lead was selected for a number of reasons. It has the necessary corrosion resistance, it is easy to machine and with maximum working pressure of only 17 lb. per sq.in., a high strength material was not needed.

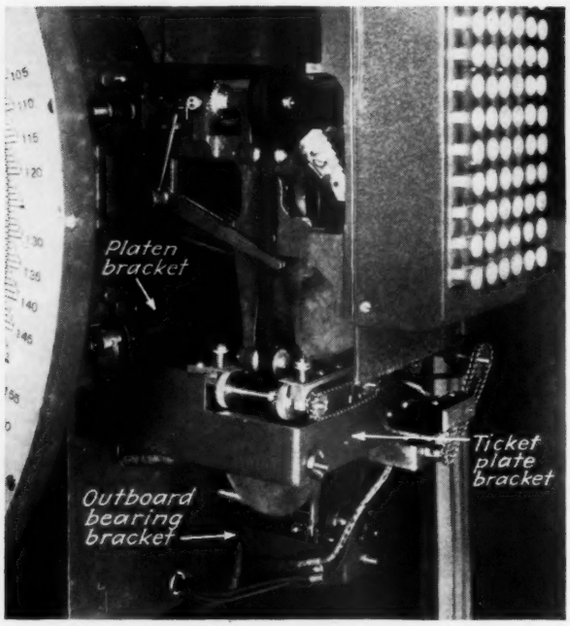
In the redesign of the all-bronze valves of the Davis Regulator Company the problem was quite different. These valves have to carry high pressure. Bodies and bonnets were changed to cast iron, piston remained bronze and bronze sleeves or linings were used for the passageways.

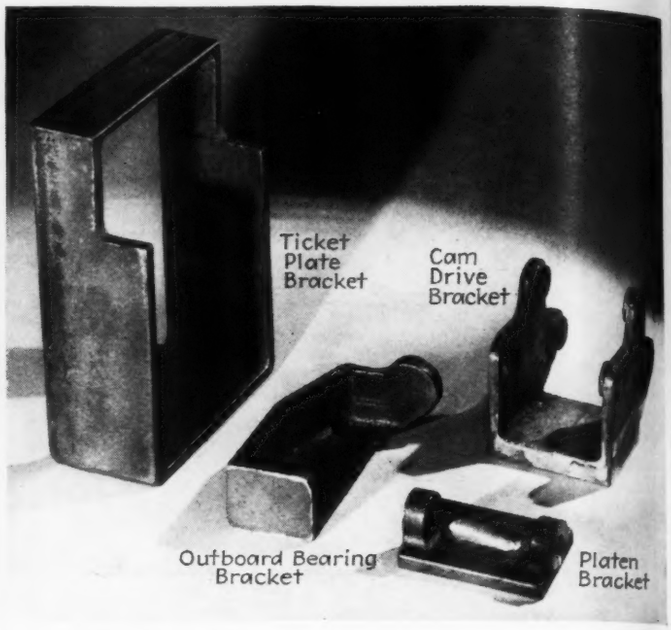
*Antimony-lead is suitable for this air-supply bracket because pressure is low and it will not rust or scale when exposed to moisture or corrosive gases*



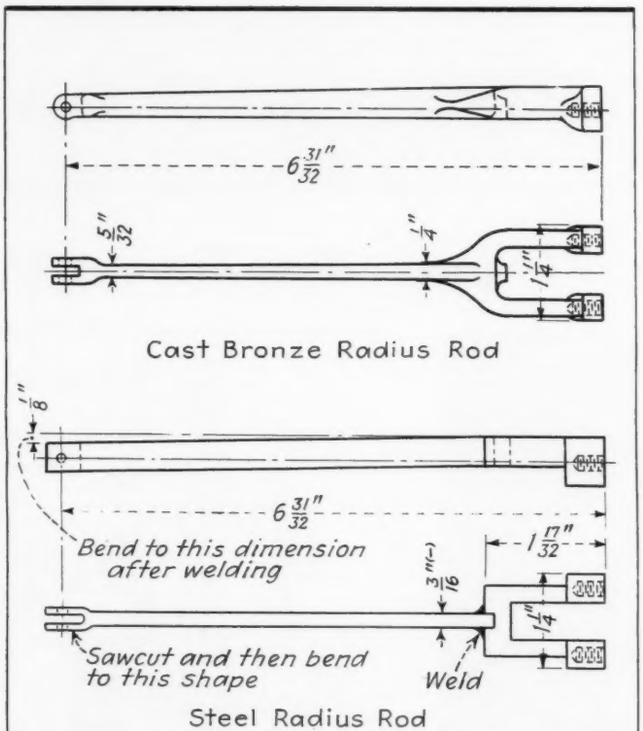

*Bronze design is left of center line and right is new design of regulator valve*

# Alternates for Non-Ferrous and Stainless in Scales

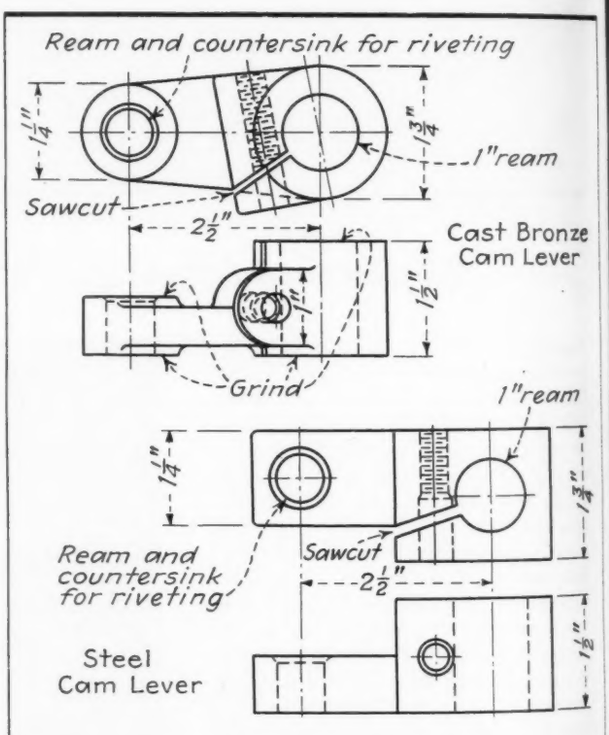


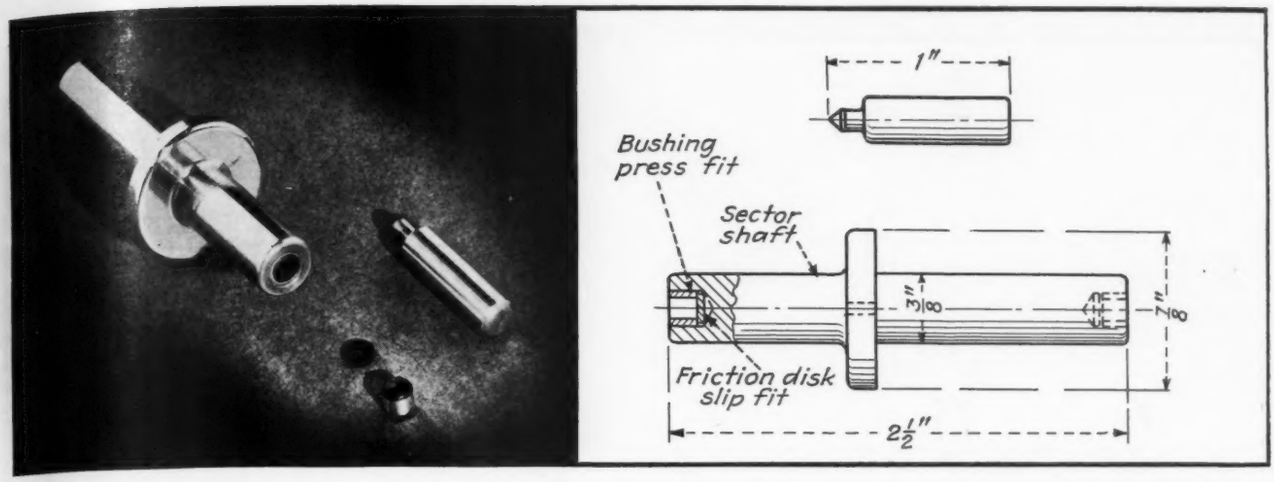

**For corrosion-resistance,** The Kron Company had long been using bronze in several cast brackets of their printer mechanism for industrial scales. When priorities hit copper alloys, specifications for these parts were changed to cast iron. Only changes necessary were adjustments for shrinkage differences and minor changes in jigs. Improved paint finishes applied to the cast iron give satisfactory protection against corrosion for the life of the scales.



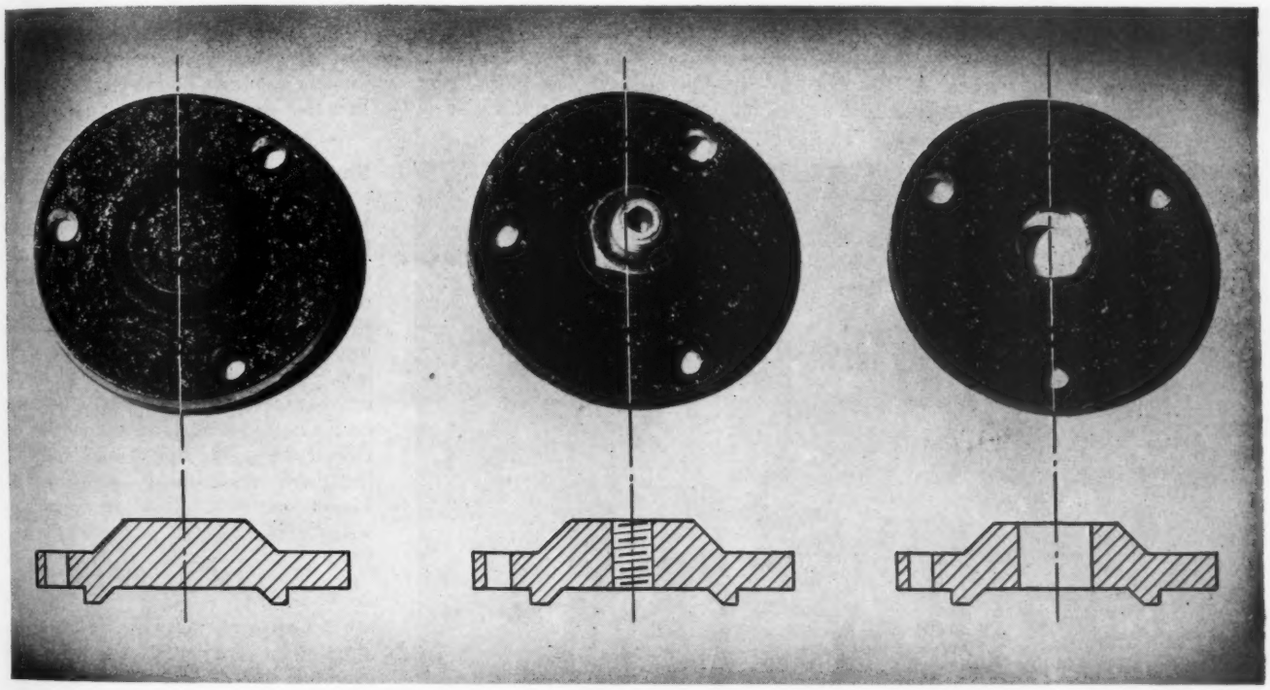

**Radius rod,** part of a Pneumatic Scale Corporation scale mechanism, originally was a bronze casting. In selecting an alternate material, weight could not be increased, and several points of contact with mating parts limited shape changes. Best choice was two pieces of cold rolled steel formed and welded as shown.




**Cam lever,** formerly bronze casting weighing 2 lb., now is machined from a cold-finished steel block 1½ x 1¾ x 4 in. Expense of two milling cuts is offset by savings resulting from elimination of grinding and use of less expensive material. Finished with air-drying enamel. Weights of bronze casting and steel part are approximately equal.

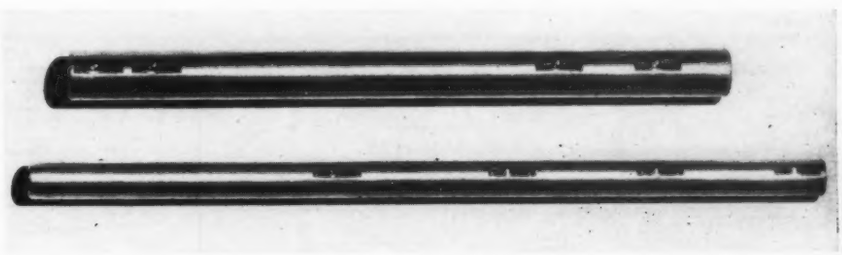


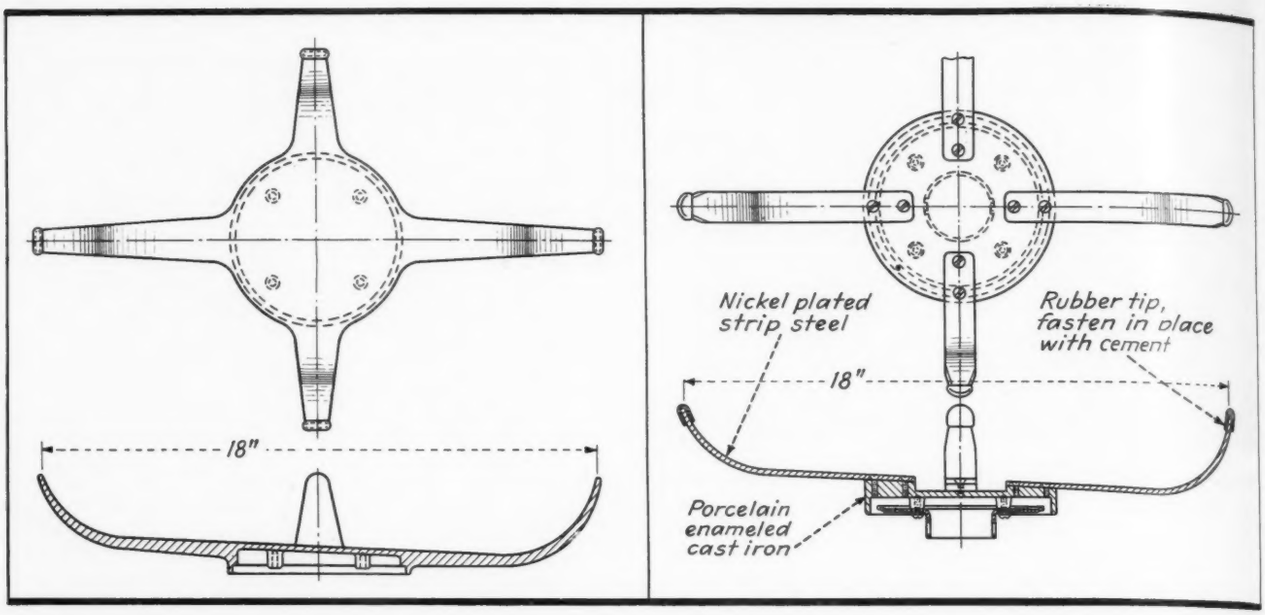

**Stainless steel bearing** inserts in this sector shaft of a Kron scale solve corrosion problem without using corrosion-resistant metal for entire shaft. Any corrosion in this bearing would seriously impair the scale sensitivity. For this reason, shaft formerly was bronze. The strategic material has been eliminated by turning the shaft from steel (S.A.E. 1020) and chromium plating it for corrosion resistance. Inserted in ends are two pieces of hardened stainless steel (carbon 0.90 to 1.00%; chromium 12 to 15%). Inserts must be free from burrs. Bushing is ground on outside diameter; reamed and lapped on inside diameter after hardening. Pin remains stainless steel.



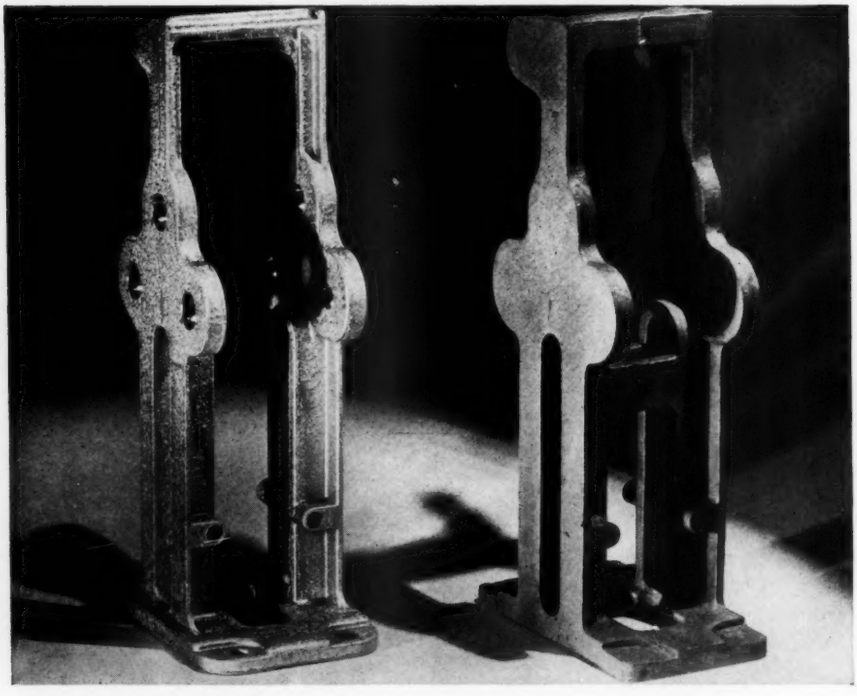
**Bearing caps** for precision scales are now zinc alloy die-castings but soon will be changed to molded polystyrene plastic, chosen for its oil and moisture resistance and good dimensional stability. Diameter is 1¼ in. Holes around edges are molded in. Same dies are used for all three caps by drilling and/or tapping center holes. Since bottom surface must be smooth and flat for tight fit, mold is designed so ejector pin marks are on top side.

**Cadmium-plated** cold-rolled steel is doing quite acceptable service in these shafts for industrial scales. Stainless steel was former material, selected to meet requirement of good corrosion resistance. Some other shafts in the scales are subject to corrosion too severe for cadmium plate to withstand, so available stocks of stainless steel are reserved for them.



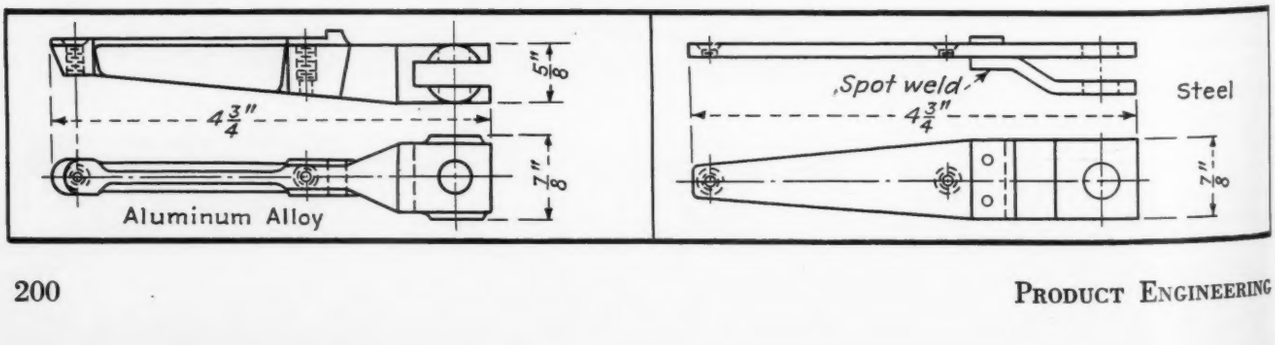


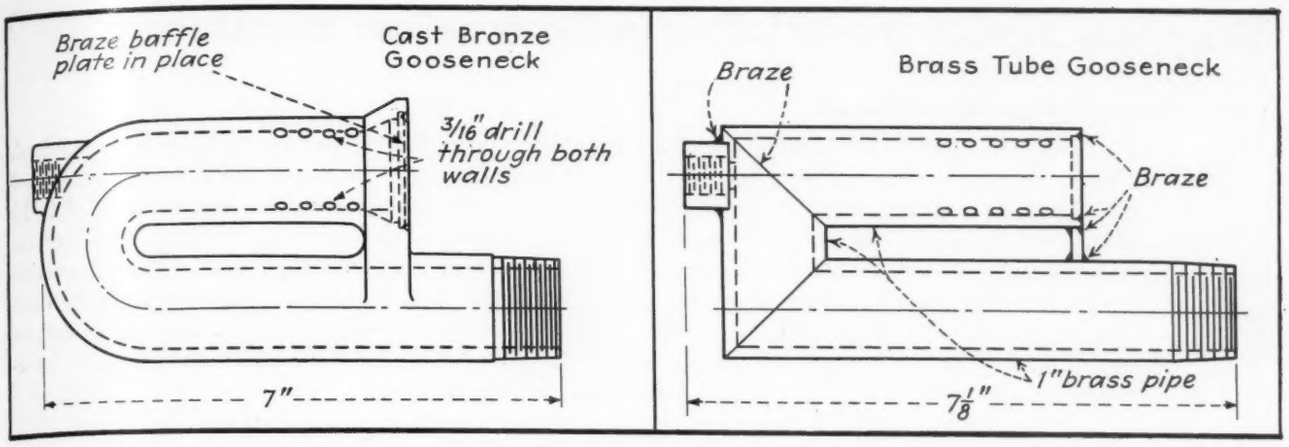

**Fish pan** and other type holders for scales manufactured by Dayton Scale Division of Hobart Manufacturing Company were formerly made in one piece of cast aluminum, as shown in the accompanying drawing. Any slight warpage in cast arms was corrected by bending. If change were made to single piece cast iron, warpage in the long arms could not be corrected in this manner, especially if the piece were porcelain enameled to match the scale case. The answer was to make the arms of nickel plated strip steel and attach them by screws to a porcelain enameled cast iron center. Machining operations include disk grinding surfaces that contact the arms, drilling and tapping.



**Some sections** were thickened, machining was increased, and weight was slightly increased when this 13½-in. high upright frame for Kron scales was changed from zinc alloy die-casting to cast iron. Lower impact strength, together with difficulties in maintaining uniform sections of cast iron were reasons for thicker sections. Similarly, cross-braces have been added half way up the cast iron upright, and lightweight ribbed design of upper half and base has given way to heavy, solid sections. Finish is light gray or aluminum wrinkle enamel.

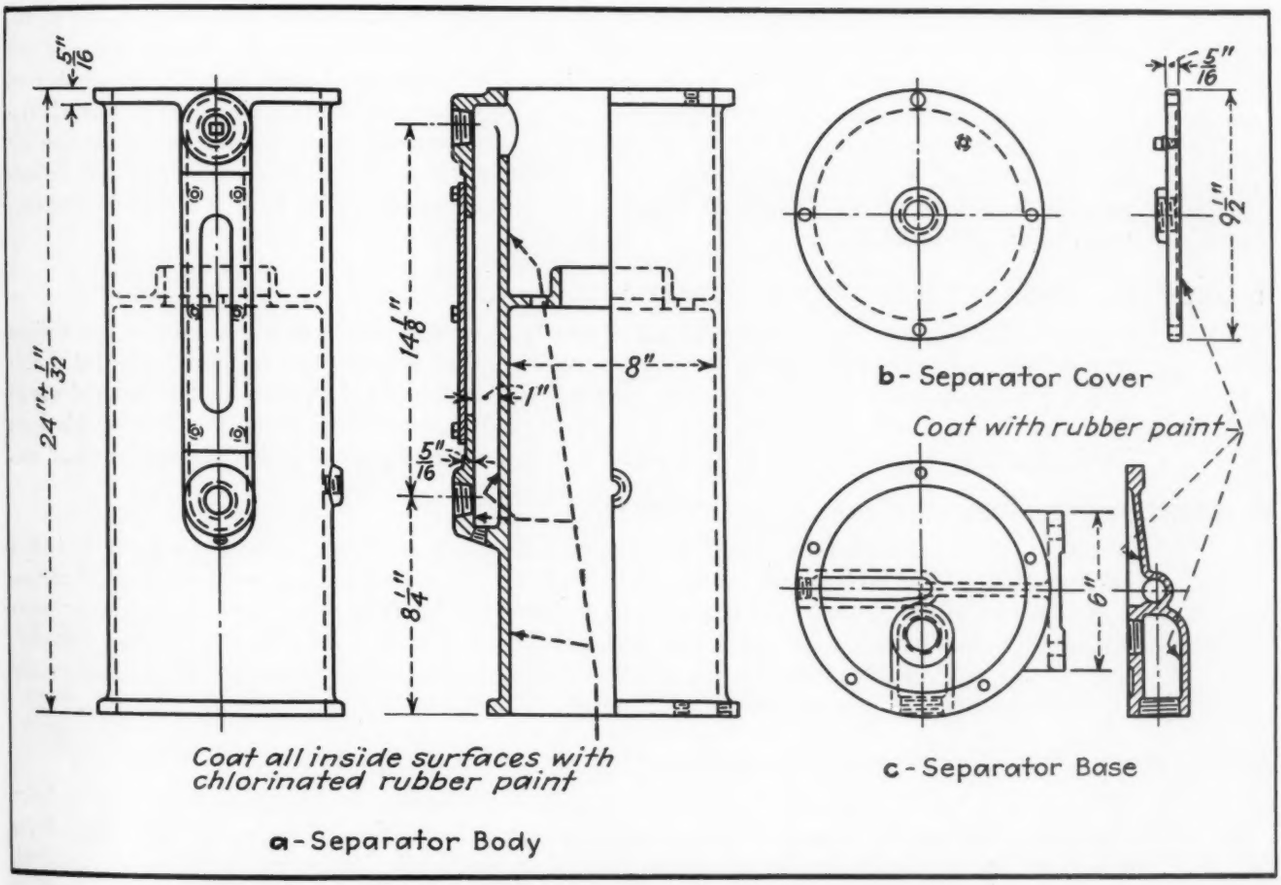
**Rail support** weighed ¼ lb. in cast aluminum. This weight could not be exceeded in redesign, so the part is now quickly and cheaply made of three pieces of plain steel, spot welded together. Although shape is radically changed, all mechanical functions are retained. It is part of a packaging machine scale mechanism.






**Instead of making** new bronze castings for this gooseneck, Pneumatic Scale Corporation utilized standard 1-in. I.P.S. brass tubing which they had in stock. The gooseneck comes in contact with corrosive liquids. In new design, tubing 12 in. long, is cut in two places to 45 deg. and assembled by brazing in an inexpensive fixture. Bronze casting weighed 3 lb.; brazed unit weighs slightly less and saves on cost. Baffle is brazed into position on both designs.

# From Stainless to Coated Cast Iron




**Although stainless steel** is the best material for many food machinery parts which come in contact with mildly corrosive materials, the two food machine parts shown above are quite large, and would require much of the strategic stainless metal. Part (a) weighs 60 lb., making high cost of stainless steel prohibitive, even if available. Pneumatic Scale Corporation has eliminated stainless steel in many parts such as these by casting them of iron, cleaning well and coating all surfaces exposed to corrosive materials with chlorinated rubber base paint. Finish is non-porous, corrosion-resistant, tough, and abrasion-resistant. New resin coatings may be substituted to conserve rubber.

# Way To Make Small Parts Corrosion Resistant

**1. NEW MATERIALS FOR VALVE PARTS**

ZINC CASTINGS in Hills-McCanna valves, of the Type AW (air and water), at 1A, included the handwheel, bonnet and compressor. All have been changed to cast iron. Attempts were first made to substitute steel plated with tin or cadmium for bronze stems. But with tin and cadmium becoming scarce, this had to be abandoned. By experiments it was found that the Pentrate process, developed by The Heat-Bath Corporation, meets the requirements and has been adopted for this purpose. Pentrate gives hard, corrosion-resisting coating which does not appreciably alter dimensions of the parts. Rubber is normally used for the valve diaphragms, Hycar or Neoprene are now being used and have been found satisfactory. Since brass washers cannot readily be obtained, laminated phenolic resin washers are now used. Parts notated on the force-feed lubricator pump valve (1) were formerly brass or bronze.

**2. PLASTICS REPLACE ALUMINUM FOR GEARS AND ZINC FOR MOLDINGS**

TIMING GEAR OF FORD CARS was originally machined from a permanent mold aluminum casting. In the finished form it weighed 1.3 lb. To replace aluminum, a plastic timing gear was designed which was made of cloth impregnated with a phenolic resin and molded. This plastic gear had a weight of only 1 lb. A steel hub is pressed in after the gear has been molded. The dash molding shown was originally a painted zinc die-casting which weighed 2.75 lb. To eliminate zinc Ford turned to plastics and the result was a new dash molding made of cellulose acetate butyrate.

**3. METAL PLATED ON MOLDED PLASTIC REPLACES SOLID METAL**

DOORKNOB MOLDED FROM A POWDER BASED on Hercules cellulose acetate flake is coated with metal by the Metaplast process. By this process plastic materials can be plated with copper, chromium, silver, gold and other metals. Properties of the finish are comparable to those of the metal employed. The chemicals used in a bonding operation impart to the plastic an affinity for metal when the part is immersed in an electroplating bath. Since a thin deposit of metal is sufficient to give to a plastic molded part many of the qualities that a solid metal piece would have, the process of plating metal on plastics offers an opportunity to save metal in the manufacture of parts which require conductive, reflective, or hard surfaces such as electrical parts, rollers, cams and gears.

**4. COMPOSITE CONSTRUCTION OF METAL AND PLASTIC**

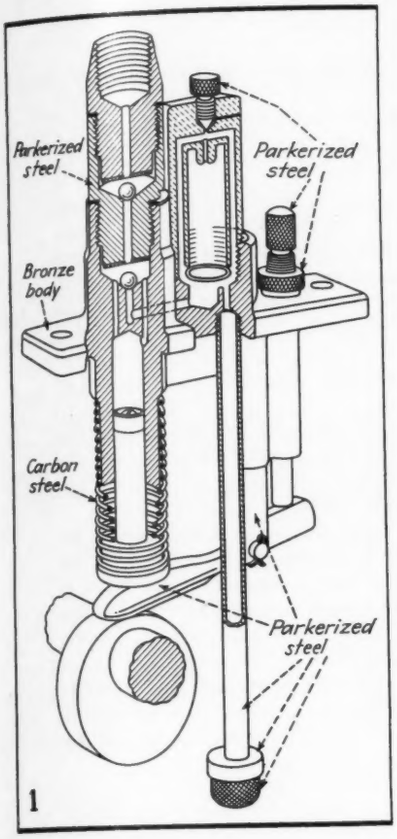
DRAWER PULLS for popular priced furniture, designed to conserve strategic metals, consist of cast designs mounted on transparent plastic disks. Amount of metal required is small, and design is such that practically any available metal can be used. First design was a plain disk of polystyrene, but this material was so clear that the disk was hardly visible from few feet away. It is now molded of cellulose acetate with slight bluish tint. Molded groove added to back surface of disk reflects light and makes plastic disk stand out.

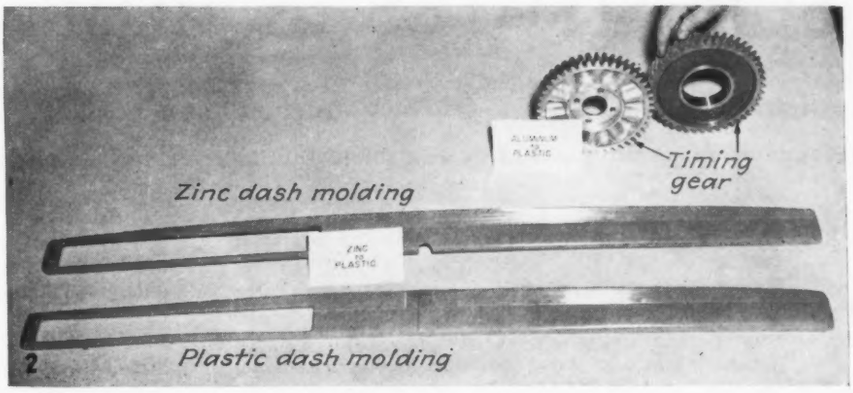
**5. ALTERNATE FOR BRASS IN HARDWARE AND FITTINGS**

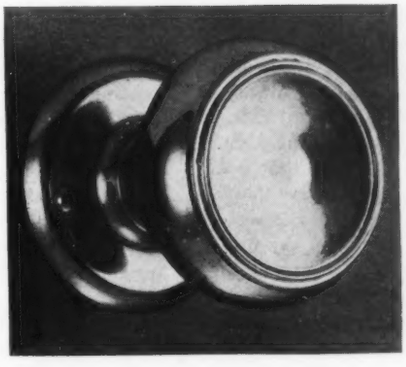
BRASS-PLATED MALLEABLE IRON CASTINGS are acceptable alternates for cast brass in many lock and hardware parts. Typical example is this trunk lock, usually cast of brass to meet rigid specifications. Appearance of malleable iron parts is practically indistinguishable from that of cast brass, and corrosion resistance of brass plating with base copper coat is sufficient in service for which this lock is intended. Hasp of this lock is still of brass because of greater machinability and strength. Barrel-type keys usually made of malleable iron are becoming difficult to obtain, and may have to be made of steel.

**6. LOCK PARTS MADE OF STEEL AND ELECTRO-PLATED**

SIMPLEST SUBSTITUTE FOR BRASS in stamped lock parts is sheet steel, gage for gage, as typified by locks illustrated. For average luggage lock the only disadvantage is addition of plated finishes required for appearance and sufficient corrosion resistance. Lock at left was polished brass, lacquered; now it is of steel, copper plated, brass plated and lacquered. Colors and appearance can be matched perfectly. Lock at right was brass, nickel-plated; now it is steel, nickel plated. Plated finishes on stamped steel often are not as smooth as plated finishes on brass, and may require more polishing. Keys illustrated have been changed from nickel silver to stamped steel, nickel plated. Steel keys are stronger, but harder, which is a disadvantage in tumbler locks which have brass tumblers which would be worn severely by the steel key. But brass tumblers will soon be changed to steel or other metal in cheaper grade locks.


Parkerized steel
Parkerized steel
Bronze body
Carbon steel
Parkerized steel
1


Timing gear
Zinc dash molding
Plastic dash molding
2



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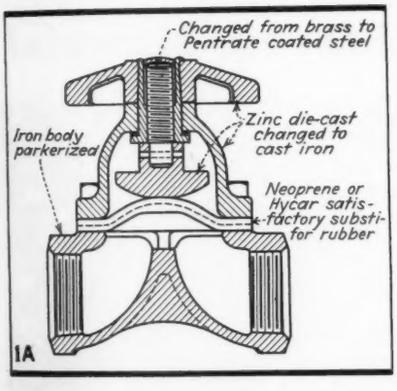
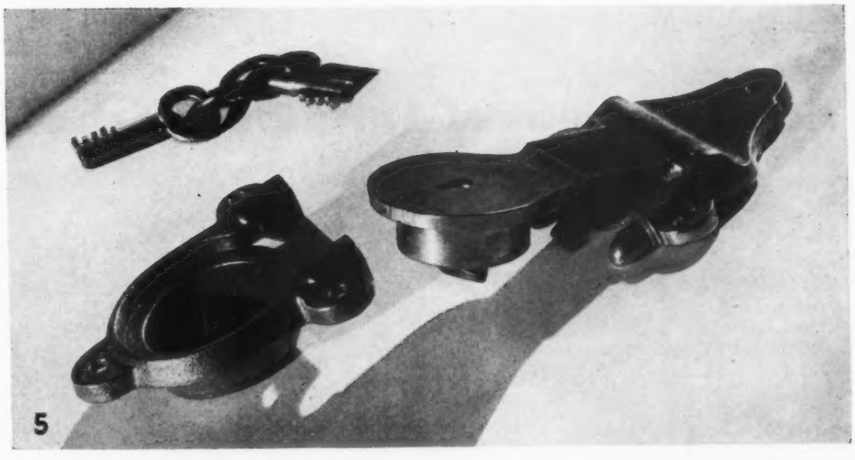

Changed from brass to Pentrate coated steel
Zinc die-cast changed to cast iron
Iron body parkerized
Neoprene or Hycar satisfactory substi- for rubber
1A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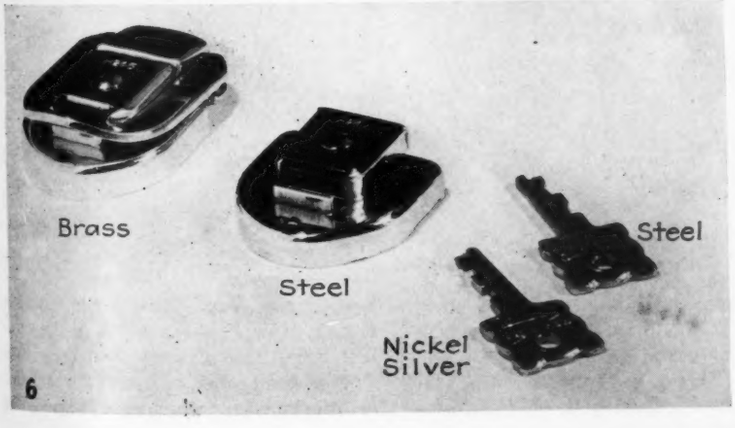
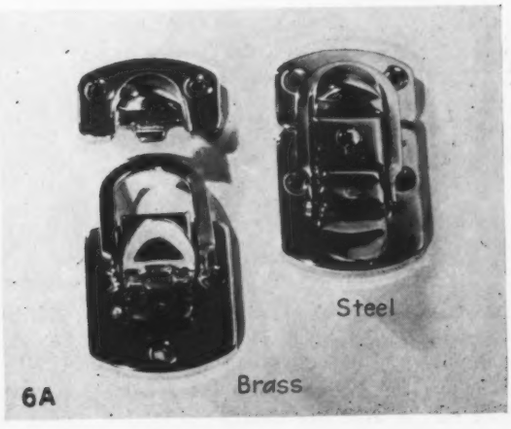

Brass
Steel
Steel
Nickel Silver
6


Steel
Brass
6A

# SUBSTITUTES IN HOME EQUIPMENT

All critical materials had to be eliminated from these products and in meeting this challenge many designers found an opportunity to demonstrate their engineering ability and resourcefulness.

BECAUSE of the great diversity of materials that enter into the design of equipment and machinery for the home, designers in this field faced many complicated problems. Frequently, the lack of the material for one small part or item prevented the production of a major article. It was soon found that many of the most popular substitutes for both ferrous and non-ferrous metals, such as phenolic resins, quickly became unobtainable when many manufacturers adopted the same material as a substitute.

Obviously, regardless of price or quality, designers were compelled to select materials that under ordinary conditions would have been considered unacceptable. However, in many instances, when such presumably inferior materials were adopted, it was found that by ingenious design the item made was far superior than had been expected. In fact, in many instances it was found that the substitute material in question was not inherently inferior. The supposed inferiority of the material was in reality only a prejudice, usually based upon tradition or past experiences with inferior grades of the material.

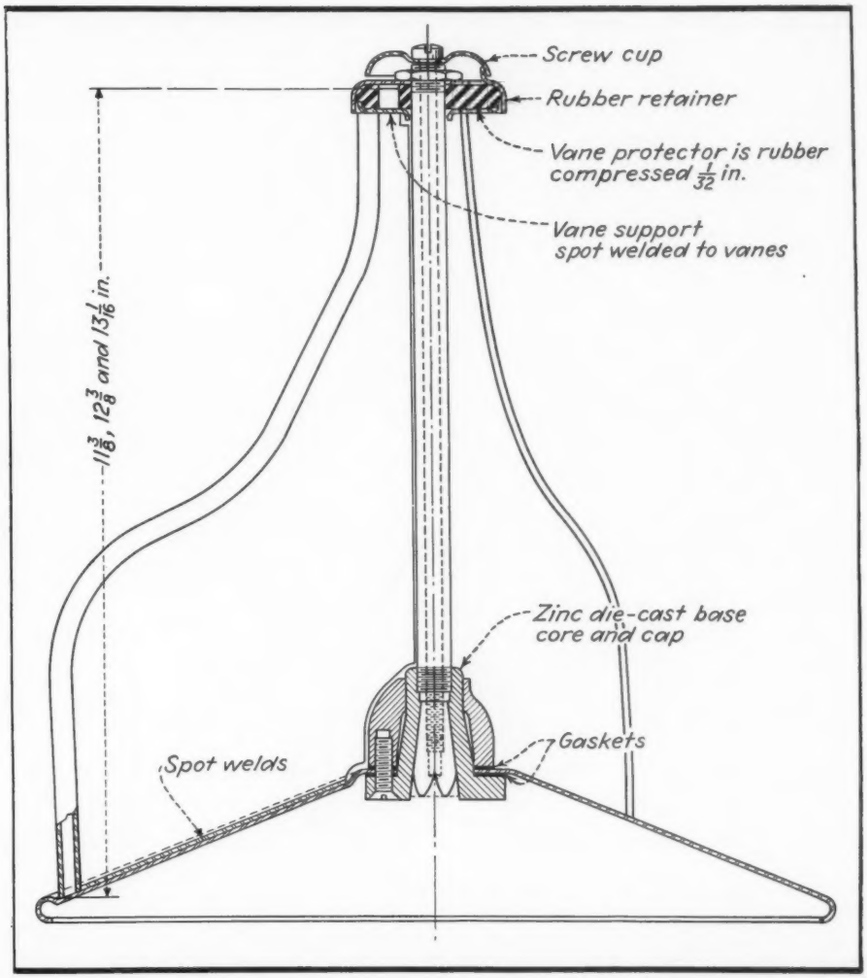
Consumers create prejudices in their minds often not because of any inherent deficiency in the material, but because a more acceptable material became available. When aluminum kitchenware replaced vitreous enamelware the impression was created that enamelware has serious defects. Admittedly, it did have, three decades ago, but during the intervening years great improvements were made not only in the vitreous porcelain enamel materials but also in the technique of its application.

Today porcelain enamel coatings are far superior to those of thirty years ago, particularly in that the coatings permit greater flexing without cracking and are highly resistant to chipping.

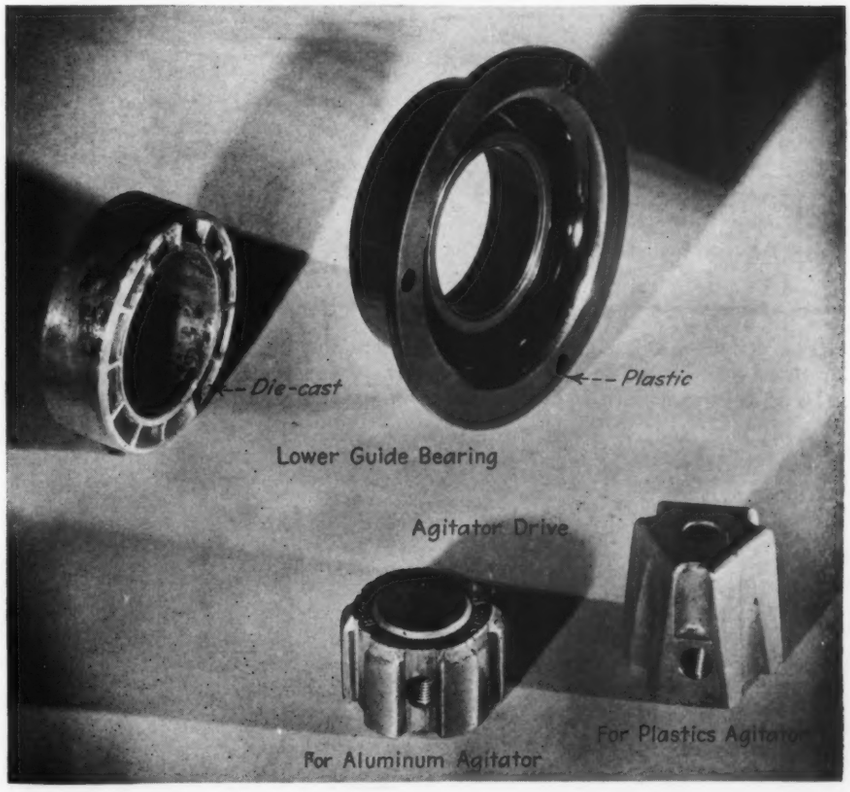
In their program for the conservation of metals the aim of the designers of household equipment, as expressed by one of the leading companies, has been to redesign the products so that there will be no sacrifice in its actual performance, although some of the materials substituted might not be as acceptable to the consumer, and in some instances appearance might have to be sacrificed. Only in rare instances has it been necessary to sacrifice durability, performance or appearance value in the redesigned products.

## Three Designs of Agitators Each of Different Material

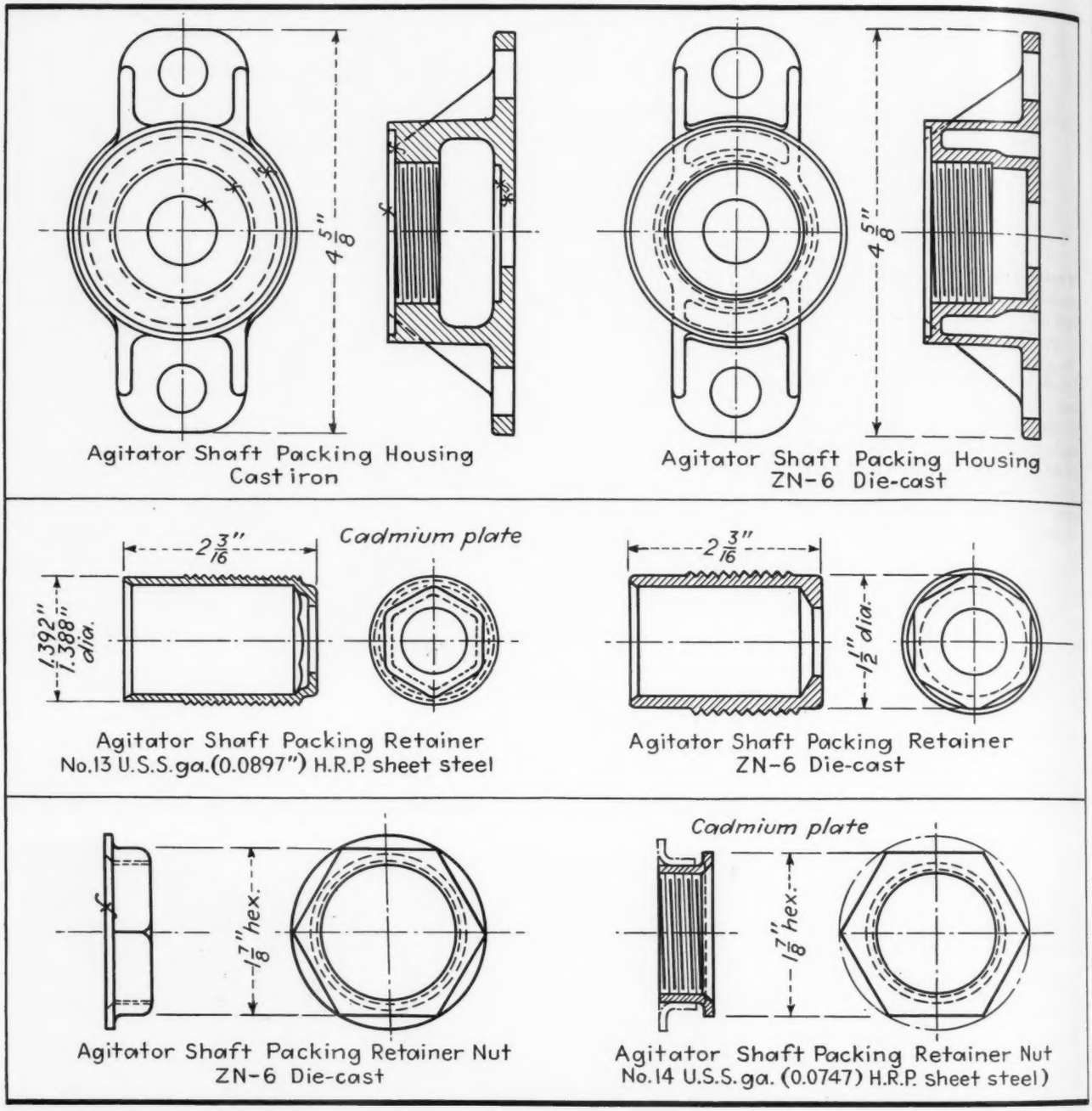
**First redesigned** aluminum agitator for Apex washing machines was almost a duplicate in phenolic resin, principal difference being a shortened lower hub with ribs to overcome molding difficulties. Necessity for turning the rim true with its hexagonal adaptor fitted in the bottom for the drive shaft was eliminated. Porcelain enameled agitator consists of three flat vanes with ¼ in. open beaded edges spot welded to a slightly coned circular stamping with beaded rim. Vanes have ½ in. flanges resting in depressed grooves in the conical base. Top of vanes converge into slots in the bottom of a cup about 2 in. in diameter to which they are spot welded. Unit is then enameled.


Screw cup
Rubber retainer
Vane protector is rubber compressed 1/32 in.
Vane support spot welded to vanes
1 1/8, 12 3/8 and 13 1/16 in.
Zinc die-cast base core and cap
Gaskets
Spot welds

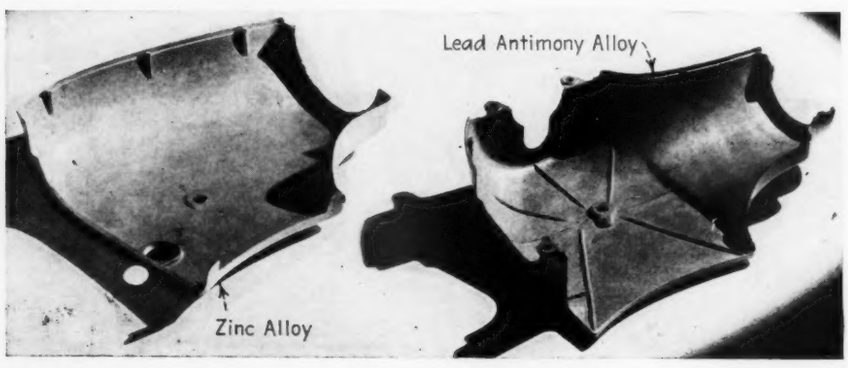
**Washing machine** agitator assembly. Sectional view shows shaft adaptor or base core is a zinc die-casting clamped to the base by means of three screws into a zinc die-cast cap under the vanes. Porcelain enameling is protected by gaskets. Upper end of base core is tapped to take threaded end of copper tube extending over top of vanes. A bolt extending through the tube holds agitator to drive shaft and retains a cover cap over the rubber vane protector and its retainer.



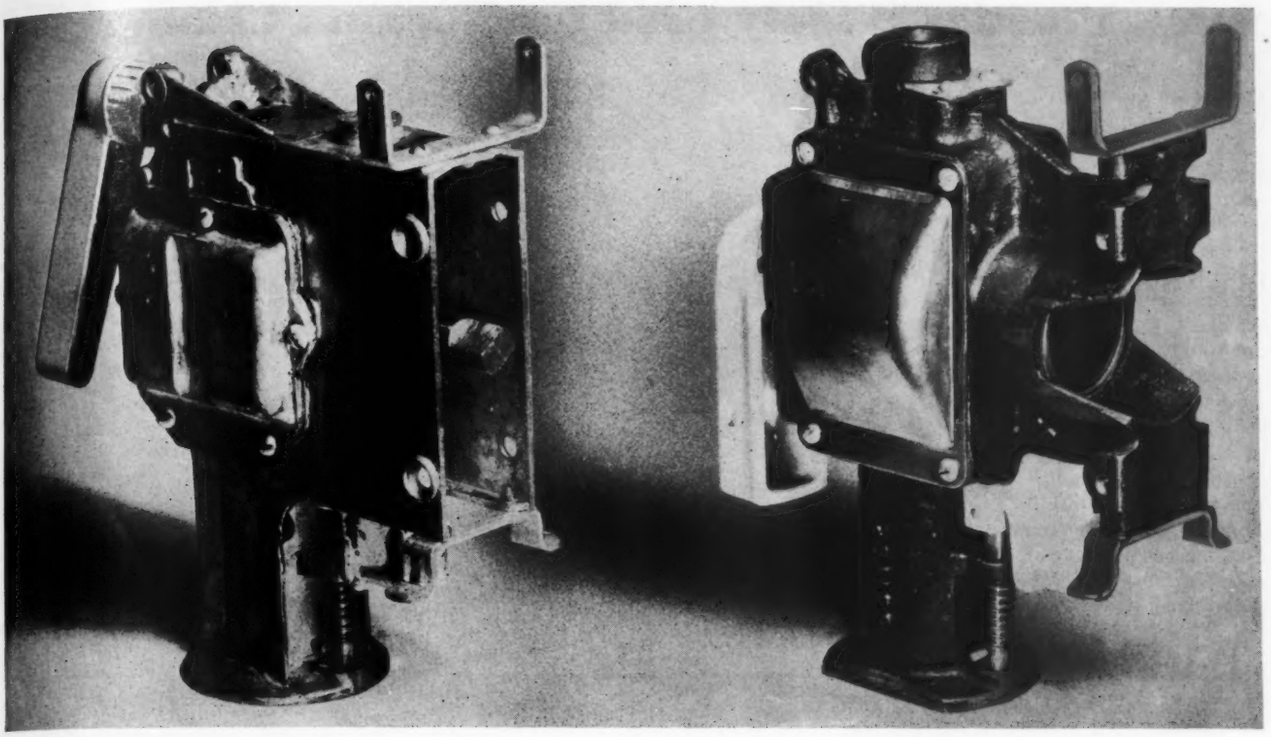

**Splined drive** for washing machine agitator had to be redesigned when switch was made from aluminum to plastics. Previous drive head was zinc die-casting splined on inside diameter to fit over splined drive shaft. Outside of drive head also had straight splines, over which recess in base of aluminum agitator fitted. This design would not compensate for dimensional inaccuracies in molded plastic agitator, and straight splines were not satisfactory with softer material. Consequently, drive head was redesigned to truncated pyramid shape shown. Recess of similar shape is molded in base of plastic agitator. Tapered sides compensate for inaccuracies and wear. Assembly was also made easier. Coincident with this change, lower guide bearing was changed from die-cast zinc to wood flour filled phenolic molding.



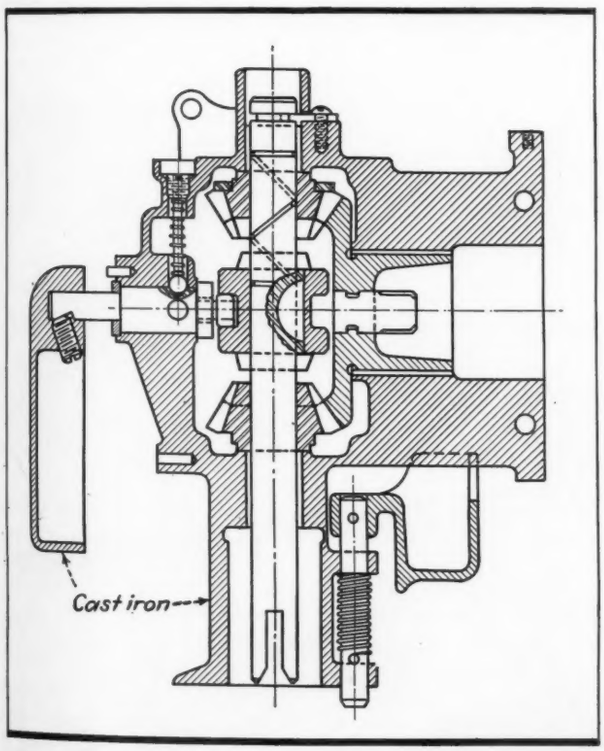

**Three** zinc die-cast agitator shaft parts for the Apex washer were redesigned to be made of cast iron and heavy-gage steel stamping. The accompanying drawings show details of changes made in packing housing, packing retainer, and retainer nut. In order to obtain corrosion resistant properties the steel parts are cadmium plated.

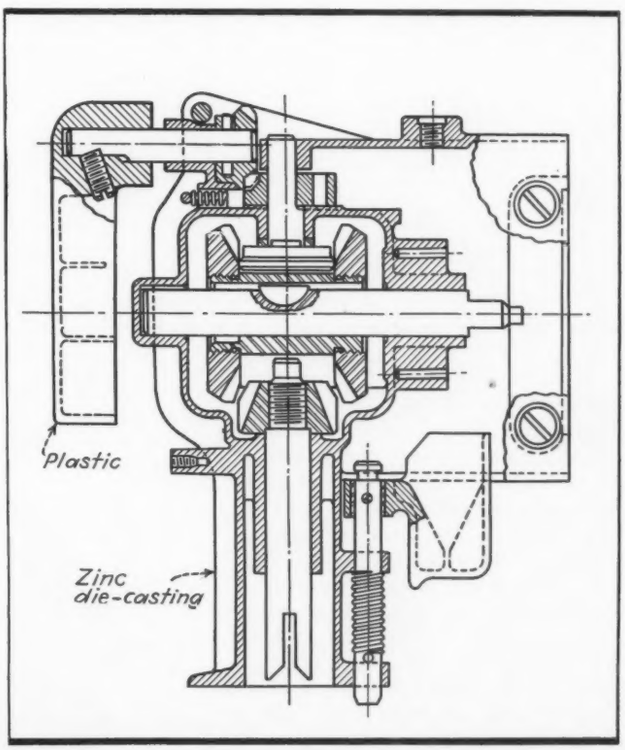



**Antimony-lead** in place of zinc for die-cast washing machine wringer cover necessitated addition of many ribs to obtain sufficient strength with weaker lead alloy. Wall remained about ⅛ in. thick. A boss also has been added around the mounting screw holes, and mounting lugs are supplemented by screw lugs. Lead cover was found to be somewhat more difficult to paint because of a tendency for the white enamel to blister during baking. This substitution is only temporary.



**Wringer head** of the Apex washing machine is an example of substitution of cast iron for zinc die-casting in which differences in casting processes were responsible for considerable improvement in design. Most obvious change is greater simplicity and increase in machining requirements of gear case. Two stamped steel cover plates are used instead of a single zinc die-cast cover. Gear shift lever, formerly of plastic, is now cast iron with white enameled finish to match head cover, not shown. Hand lifter for latch was also changed from zinc to cast iron.

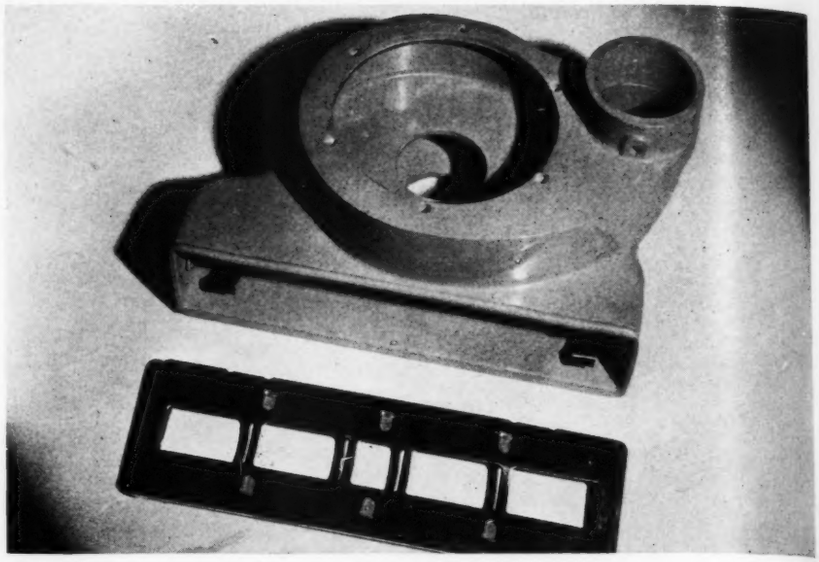


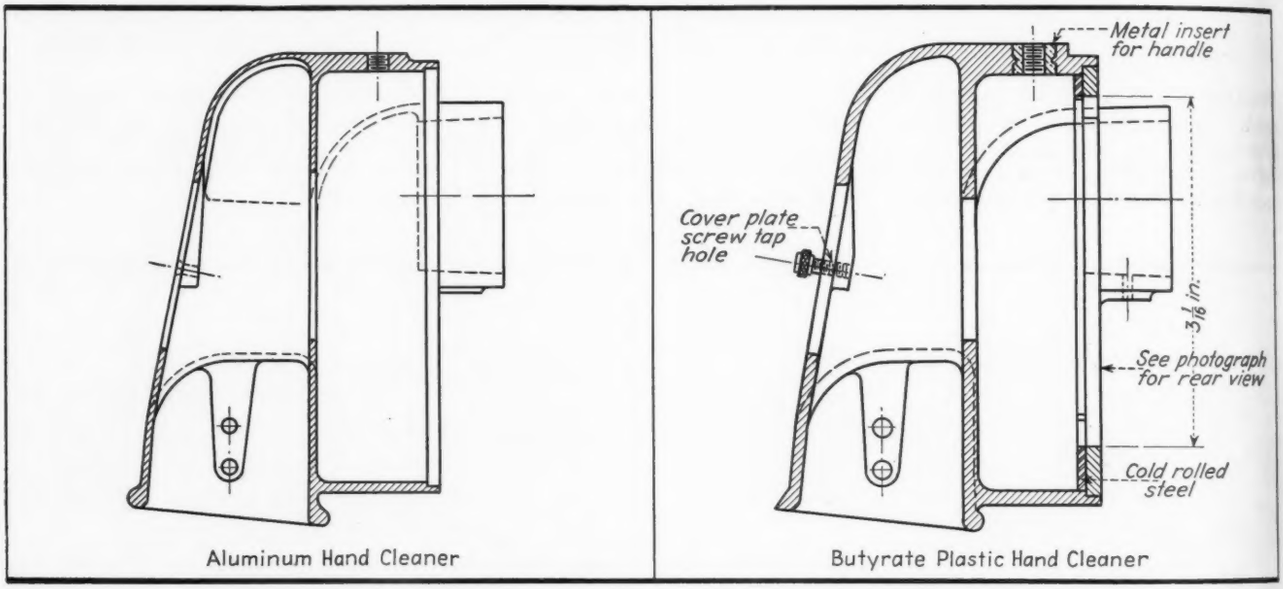




**In the present design,** wringer drive gears are constantly in mesh, gears being shifted by a sliding jaw clutch loosely keyed to vertical drive shaft and positioned by hand lever. The older design employed a zinc die-cast bevel gear on hand lever shaft, as shown, to slide a pair of bevel gears attached to opposite ends of a common sleeve loosely keyed to the horizontal wringer drive shaft. Shock of gear shifting is taken by gear teeth.

# Steel, Plastics Widely Used for Vacuum Cleaners

**Cellulose acetate** or acetate-butyrate plastics are often chosen to replace cast or die-cast aluminum in vacuum cleaner nozzles and housing parts. Advantages are light weight, complicated shapes possible, and availability of unlimited colors. Good example is General Electric Company's hand cleaner. Plastic housing is molded in two parts and cemented together. Steel ring ⅛ in. thick adds strength to motor mounting at back. Ring has four lugs which are forced into small slots molded through back edge of fan chamber while plastic is still warm and flexible. Aluminum saved in this part is 0.7 lb. per cleaner. The cap, representing 0.22 lb. of sheet aluminum, has been changed to sheet steel. Because of the light weight of the plastics, total weight of the unit is slightly reduced.

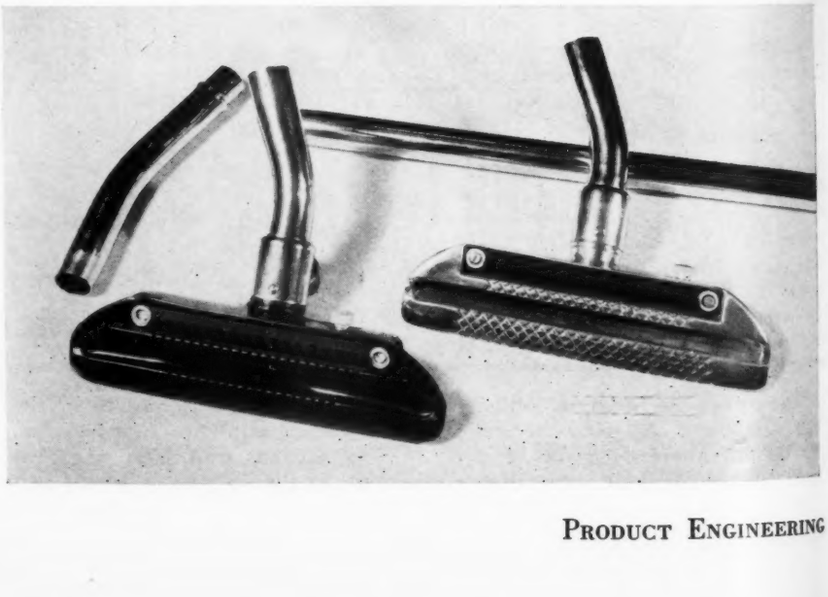


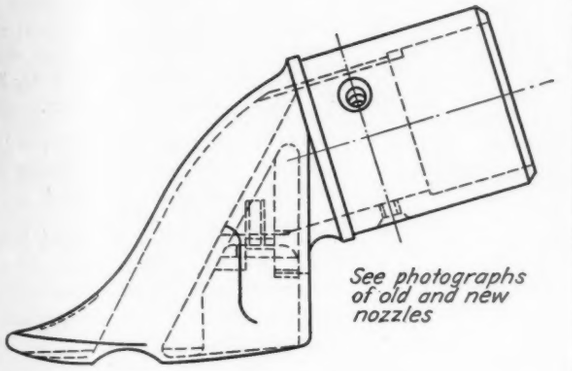



Aluminum Hand Cleaner

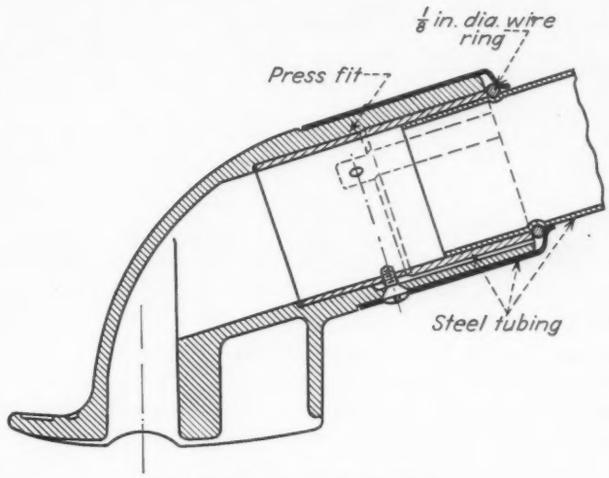
Butyrate Plastic Hand Cleaner

**In the new plastic** floor nozzle of Premier tank cleaner made by the Electric Vacuum Cleaner Company, principal design changes were to allow for differences in casting and molding methods. However, advantage was taken of the opportunity to reduce cross-sectional area of the nozzle to improve nozzle suction. Coring was straightened in the vertical, simplifying molding by paralleling the cores. The tube handle is attached by means of three screws threaded into an inner steel tube as shown by drawing. Screws holding the brush have wood-screw threads and cut their own thread into a 0.100 in. dia. hole. The handle is now chrome plated steel instead of aluminum.

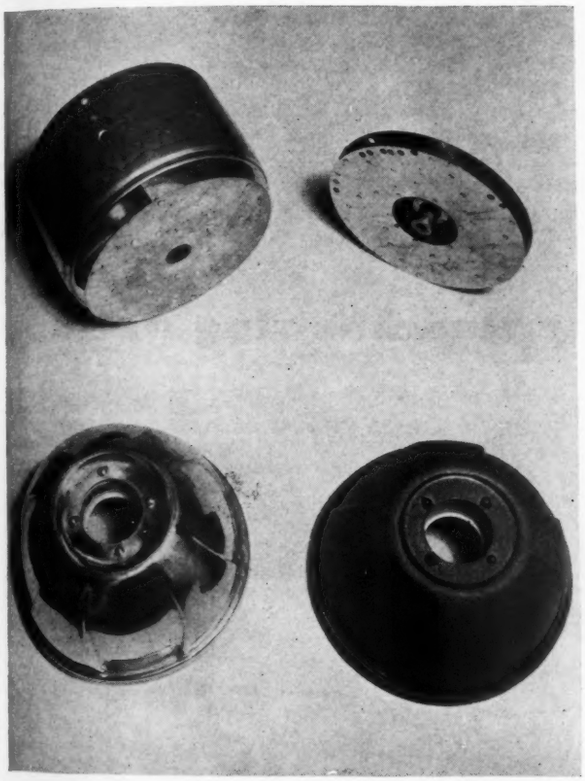




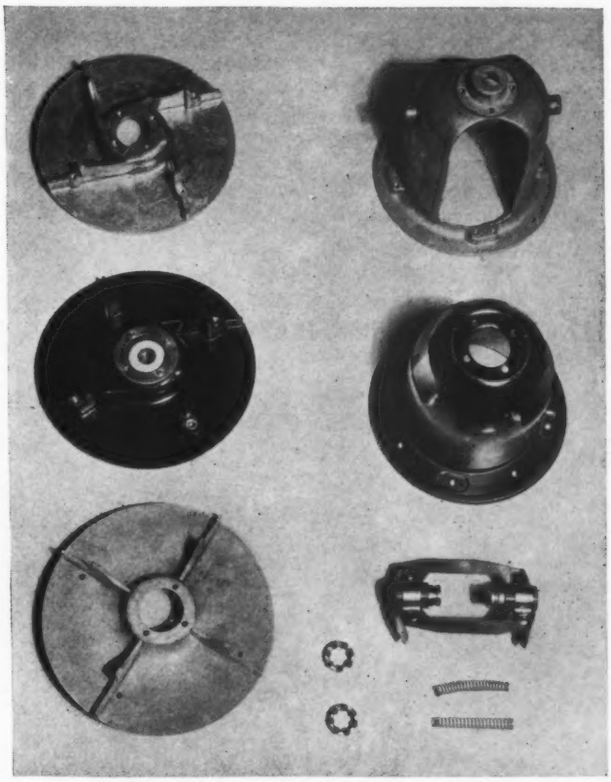

Aluminum Floor Nozzle



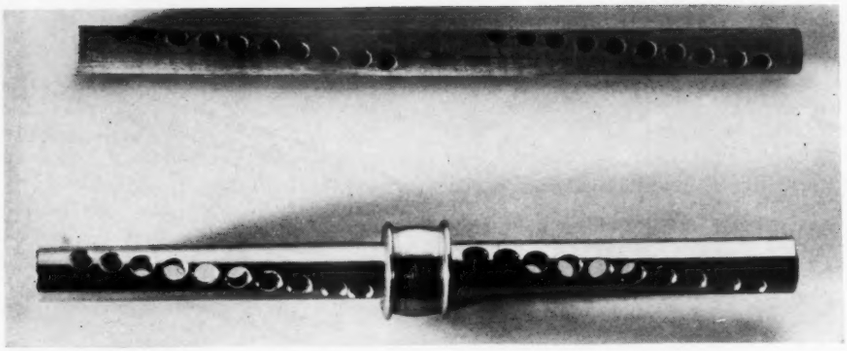

Butyrate Plastic Floor Nozzle



**Three stamped** and fabricated sheet aluminum parts that were changed to similar parts of steel are shown here. They are the rear fan housing and motor support at upper left, one of the two fans, at upper right, and the end caps, below. The original cap of polished aluminum is at the left and the steel cap, with wrinkle lacquer finish, is shown at the right. The lacquer finish has the advantage of allowing choice of color which compensates for the usual high polish given to aluminum parts. No changes in design were necessary on any of these parts. However, some reduction in metal thickness was made. In the fans this amounted to 40 percent so that weight increase was only 5 to 10 ounces. Motor housings (not shown) for a floor type cleaner are two sheet steel parts; too deep a draw is required for one piece.



**Sheet steel stampings** replaced many aluminum parts in the Premier tank type vacuum cleaner. Die-cast aluminum motor base was changed first to a nearly identical design in phenolic type plastic. A stamping with flat cut vanes attached by spreading three split projections through holes was then developed. Sprayed paint may later replace its cadmium plating. Motor cap, formerly die-cast, is now stamped from 0.042-in. sheet steel. Brush holder frame, formerly integral with cap, is a separate stamping with spot welded straps. Two screws hold it inside motor cap. Sixteen tapped holes in aluminum cap were eliminated. Three other parts now made of steel are brass bearing retainer cup shown resting on aluminum motor cap, brass ball bearing retainer, and carbon brush spring, formerly beryllium copper or phosphor bronze.



**Rotary brush** for floor-type vacuum cleaner consists of metal tube slipped over wood core. Bristles are tufted into holes drilled through tube into wood. Tube originally was aluminum. First materials change was to brass, nickel plated. Now in production is seamless steel tube, also nickel plated.

### SAVED 5.12 LB. OF ALUMINUM PER CLEANER

Out of a total of 5.12 lb. of aluminum used in each General Electric floor-type vacuum cleaner during the first half of 1941, 2.12 lb. had been eliminated by the middle of the year. The remaining 3 lb. represents the main housing, and will be eliminated early in 1942. Some brass also has been saved. Since plastics are alternate material selected for many parts, weight of the cleaner has not been increased. Maximum weight limit is about 20 lb. Redesigns were:

MAIN HOUSING. Welded steel fan chamber to which is attached wheels, axle, and other parts. This assembly is covered with 4-piece plastics assembly to form complete machine. Base and light hood of housing are phenolic plastics (wood-flour filled) for strength and heat resistance. Two side panels over motor housing are cellulose acetate-butyrate.

MOTOR HOUSING. Die-casting of 95.5 percent aluminum changed to drawn steel construction. In redesigning it was necessary to make two drawn steel parts and weld them together to avoid deep draw of one-piece construction. This part is similar to the motor housing of the tank type cleaner.

SMALL PARTS, such as studs, punchings and others, have been changed from aluminum to brass and steel.

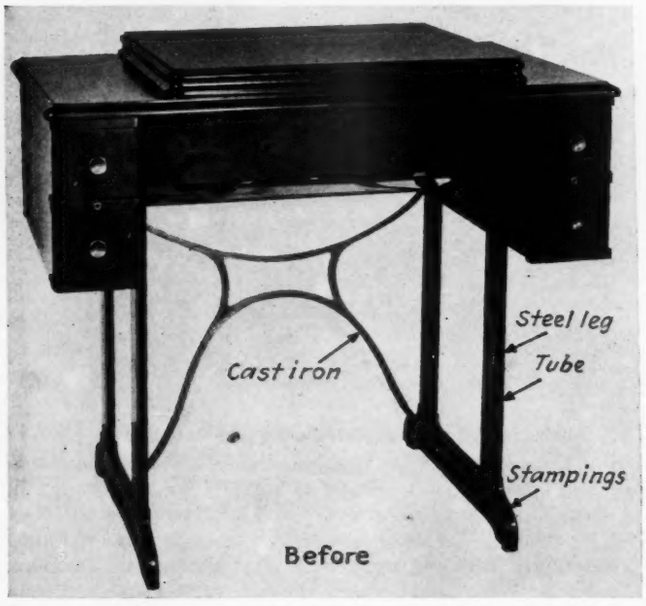
SUCTION PLATES at front of housing have been changed from etched brass to plated steel. On machines with plastic housings, it will be made of acetate-butyrate plastics.

BUMPERS. No change has been made yet, but experiments with felt and cloth-felt combinations indicate that either may be satisfactory in place of rubber.

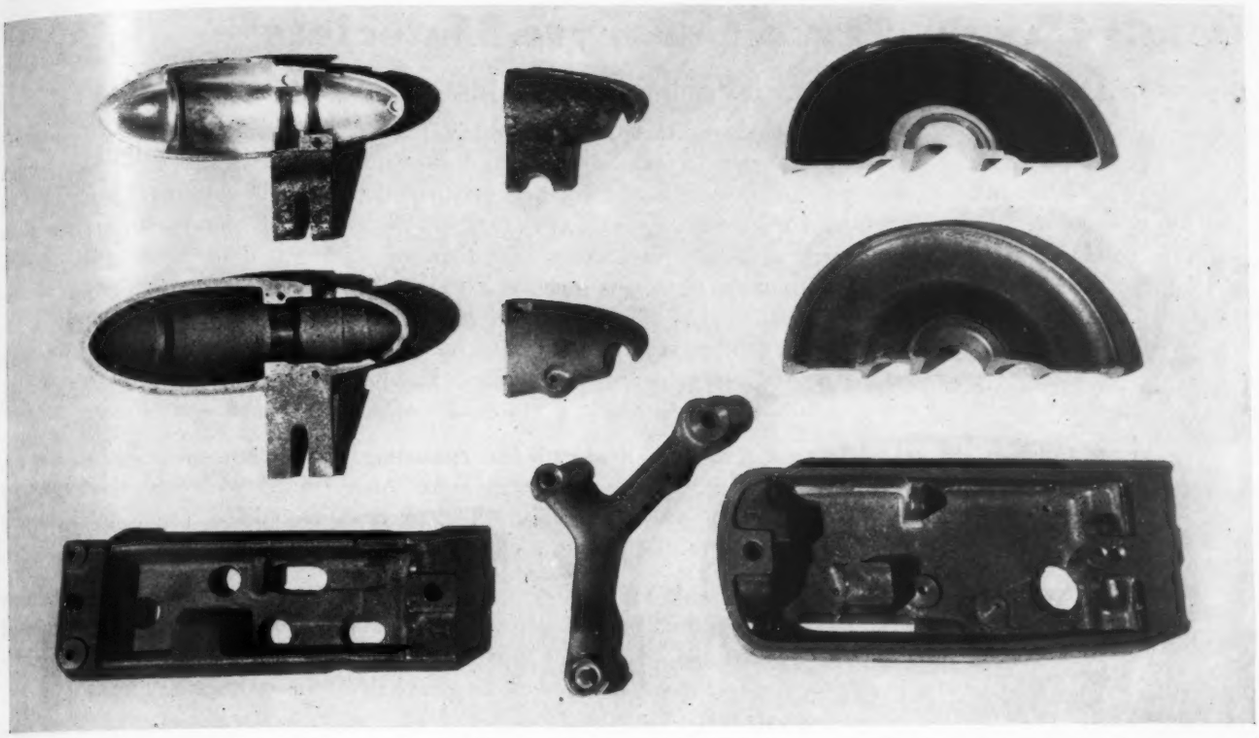
WHEELS are now made of either hard rubber or a combination of hard and soft rubber. These will be redesigned for plastics or wood.

CONDENSERS. Most vacuum cleaners are equipped with capacitors to reduce radio interference. Rather than redesign this item to avoid using strategic materials, they may be eliminated.

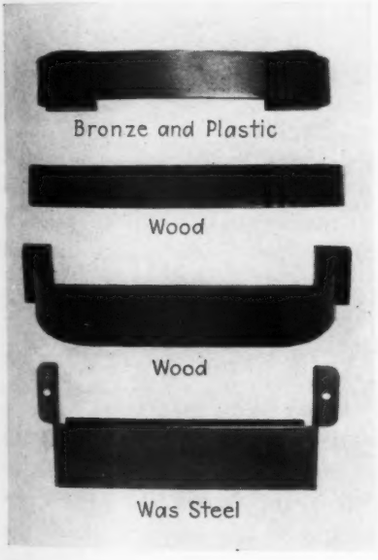
# More Wood and Iron in Utility Model Sewing Machine

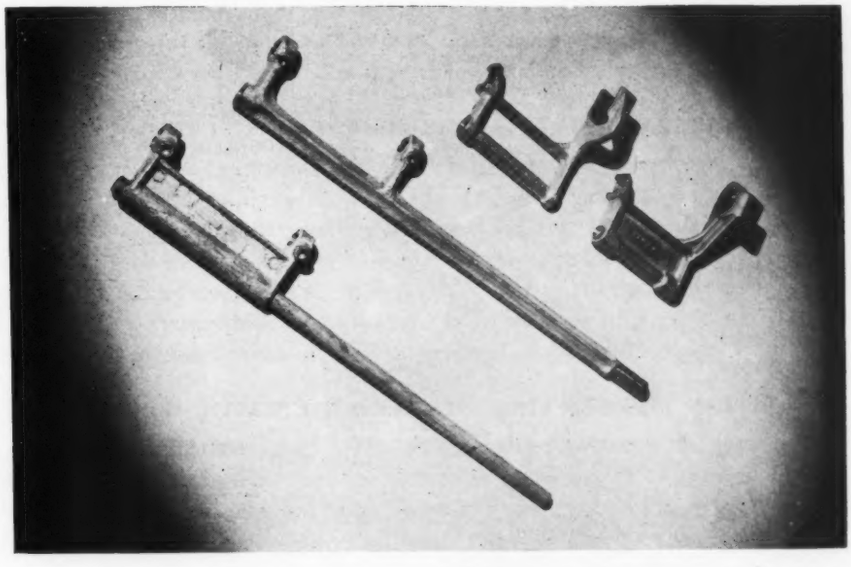


**Substitution of wood** for metal was a simple matter for White Sewing Machine Company in the base of its utility model machine, shown above before and after redesign, since the company had its roots in a cabinet-making firm from the beginning. Bracing of the stand was cast iron and legs were sheet steel stampings formed in rectangular cross-section. The new sewing machine stand is entirely of wood, as of course are most of the finer White models. The leg design is a reproduction of the tubular steel legs in wood and the new wood bracing follows the style of the legs. Some 360,000 lb. of steel per year would be saved on the basis of past year's operation.



**These sewing machine parts** are examples of changes from zinc die-castings to gray cast iron. Plastics were considered first for the electric lamp shades at upper left but phenolic materials soon became unobtainable, and cast iron was used. No machining other than drilling screw holes for joining the two iron parts is necessary. Self-tapping screws dispense with tapping. Use of gray iron in the conspicuous hand wheel presented a problem in casting accuracy to avoid appearance of eccentricity when in motion. This was solved by rounding out contours, as shown in the two half wheels at upper right, and by using accurate patterns and careful molding in the foundry. The iron hand wheel is almost equal to the zinc wheel as far as being concentric is concerned and machining is confined to rim and bore as on the zinc wheel. The two face plates shown below require more machining, of course, than zinc die-castings which they replaced. Same is true of lever arm in center. Original zinc parts are not shown.



**Other sewing machine parts** changed to wood from sheet steel, bronze, and plastic are the drum or under apron of the machine, the spool and accessory drawer, and drawer pulls. Wood in the form of a 12 by 14 by ¼ in. Masonite board is now used for the drum. A wooden spool drawer is, of course, not new but some economies had been made by using sheet metal. Dozens of designs for wooden drawer pulls are now available, many of which have finishes giving the appearance of metal.

**Malleable cast iron** of simpler designs replace die cast aluminum in these two parts. Conical steel bearing inserts, used in the smaller aluminum part, are not required now and the larger part is now of one material rather than aluminum formed over steel rod.

# Detail Changes That Conserve Materials

### 1. SOME OF THE CHANGES IN GENERAL ELECTRIC REFRIGERATORS

MOST DIFFICULT PROBLEM in changing this General Electric refrigerator evaporator from stainless to porcelain-enameled steel was to prevent chipping caused by deflections. Enameling steel only thick enough to withstand internal evaporator pressure would not be heavy enough; deflections would be sufficient to cause chipping. Therefore, a heavier gage steel was necessary. The bead of the evaporator is the point most likely to chip, so special technique for making solid rounded beads was developed. After evaporator had been welded, formed, and annealed, it is tested at high pressure. This pressure slightly separates the sheets along the seam welds and gives the louvres their final shape. Otherwise this shaping up might occur under maximum operating pressure after enameling, causing the enamel to chip. When two coats of enamel are applied, the second coat is wiped along the bead. Also important is uniform cross-section of metal so that entire evaporator can be brought up to enameling temperature at same time.

Steel nipples are welded to steel evaporator headers before enameling. Nipples are enameled half-way up, and the copper tubes are silver-soldered into their open ends. After soldering, a portion of the steel nipple is left exposed, in contact with silver and copper. To prevent electrolytic corrosion under extreme conditions of moisture and temperature, the nipple is coated with baking enamel.

Refrigerator shelves were formerly made of steel wire with a heavy tin coating, or of chromium stainless steel wire. Satisfactory alternates now used include steel wire (1) zinc plated, Bonderized and finished with tough, abrasion-resistant baked enamel, or (2) porcelain enameled. Principal requirement is abrasion resistance of coating, since glass refrigerator dishes often have sharp fins on their bottoms.

### 2. REFRIGERATOR DOOR NOW MADE OF PORCELAINED STEEL

ALUMINUM was formerly used for the side strips of Westinghouse refrigerator ice-cube compartment doors. The center portion is plastic, the same as in the new type door.

### 3. PORCELAINED COVER REFLECTS LITTLE HEAT

HEAT REFLECTING PROPERTIES are often a consideration when selecting alternates for aluminum. Aluminum cover originally used on General Electric roaster was polished on inside surface, and reflected heat back into foods being cooked. When porcelain enameled cover was designed to replace aluminum, it was found that the white enamel did not reflect enough heat to brown cake. Hence a simple chromium-plated steel reflector baffle was designed to set into the top of the roaster just beneath the cover. Consumer is instructed to form habit of using baffle at all times, although it is only required where heavy browning is desired. Cooking vessels in roaster have been changed from aluminum to heat-resisting glass.

### 4. PORCELAIN ENAMEL IN PLACE OF BRIGHT PLATED TRIM

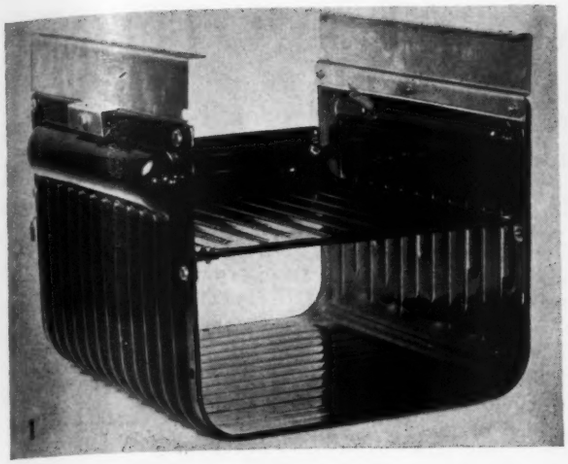
DESIGN POSSIBILITIES OF PORCELAIN ENAMEL as an alternate for polished plated finishes where corrosion-resistant, heat-resistant, easy-to-clean surfaces are required are illustrated by electric iron and toaster housings of General Electric Company. Iron is plain white; finish on toaster is attractive silver-opalescent vitreous enamel. These enameled finishes can also be produced in color, for greater sales appeal. Principal consumer objection is danger of chipping, overcome by keeping thickness of coating to a minimum. Strategic formaldehyde is conserved in plastic bases and handles by switching from urea formaldehyde and phenol-formaldehyde compounds to plain black or brown phenol-furfural molding compounds.

### 5. SLIDE BAR CHANGED FROM STAINLESS TO PLASTIC COVERED STEEL

SLIDE FOR GLASS MEAT PAN in General Electric refrigerator was formerly stainless steel strip. More than skin-deep corrosion protection is required because of severe abrasion. Alternate design now in production is extruded strip of cellulose acetate butyrate plastic, slipped over steel strip and fastened by pressing the thermoplastic with hot irons into holes punched in the steel strip. Unexpected advantage of plastic was elimination of steel-against-glass sliding noise.

### 6. RANGE DOOR HANDLES IN THREE DIFFERENT MATERIALS

THREE ALTERNATE MATERIALS for range door handles are illustrated here. Two of them, chromium-plated brass and urea plastics, are materials that are now unavailable for non-war products. The handle now in production is formed steel of same construction as brass handle, finished with light gray melamine resin baking enamel. Recess in handle is wiped in with white enamel.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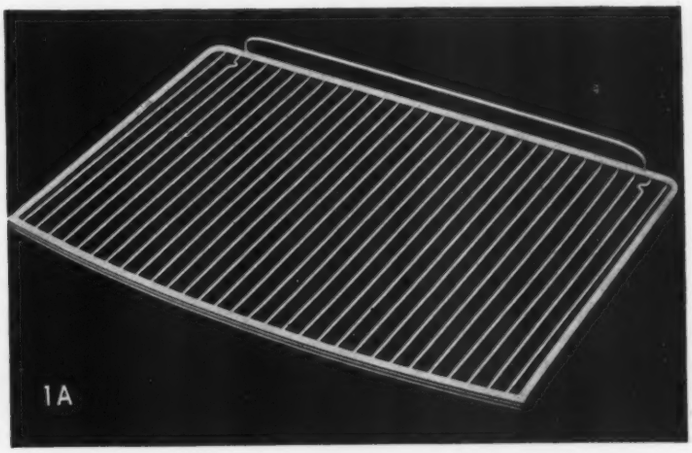
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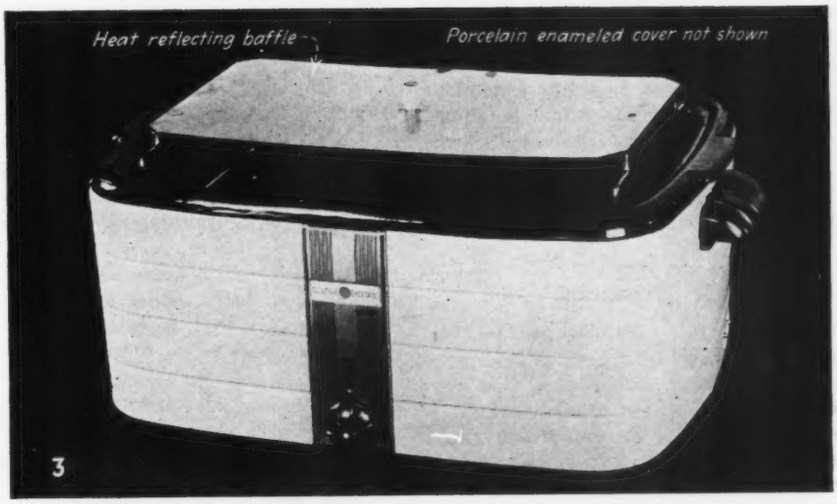
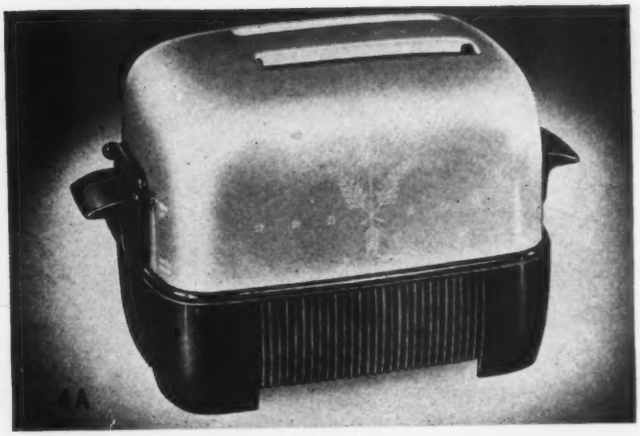

Heat reflecting baffle
Porcelain enameled cover not shown
3

4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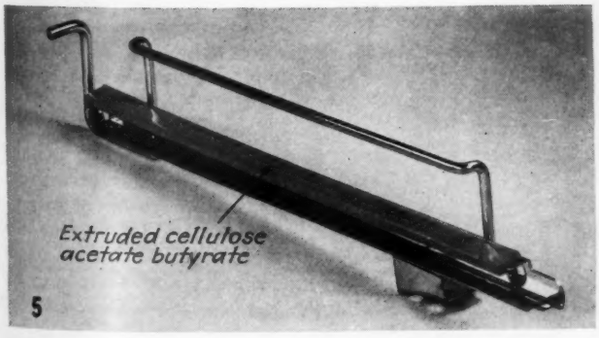

Extruded cellulose acetate butyrate
5

6

# REDESIGNS BY GENERAL MOTORS

Here are shown only a few of the many significant redesigns developed by the engineers of the various divisions of General Motors in order to minimize the amount of strategic material entering into the manufacture of automobiles.

### REDESIGN ELIMINATES ALUMINUM IN STEEL

As originally designed, the Chevrolet fender was made from a single sheet of steel, the shape of the fender being drawn in heavy presses. In order to obtain the deep draw required, it was necessary to use "killed steel" which contains a small amount of aluminum to prevent hardening in storage and to improve the drawing qualities. When aluminum became scarce, the fender was made in two sections that required only a shallow draw. Thereby "killed steel" was not required, aluminum was saved and ordinary deep drawing steel could be used.

### ALUMINUM COVER NOW SHEET STEEL

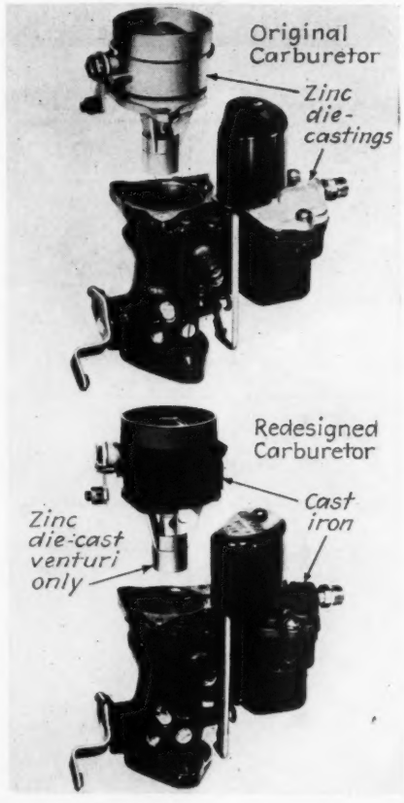
Cover for oil cleaner, because of aluminum shortage, has been redesigned by Pontiac engineers for fabrication in pressed steel to take the place of a die-casting. Efficiency in removing dirt from the oil was increased by making the new design greater in diameter, by using two baffle skirts instead of one, along with some changes in flow contours that reduced the velocity of the oil stream. In the old design the baffle skirt was a horizontal shelf which deflected the flow of oil sharply upward, any dirt deposited on the shelf was wiped off by radial flow, after which the dirt settled by action of gravity to the bottom of the cleaner. In the new design the baffle skirts flare conically downwards so that any dirt deposited on the lower skirt is removed by a gravity component as well as by the flow of oil. In the new design the outlet pipe connection is central thus promoting a more uniform distribution of flow around the entire skirt circumference.

### ZINC ELIMINATED FROM FUEL PUMP

Fuel pump originally used on the 1942 General Motors cars was a zinc die-casting. When zinc became scarce and a reduction in its use was necessary, interchangeable substitute fuel pump assemblies had to be designed. Experimental work was done on both stamped steel and cast iron fuel pumps. Both performed well, but the cast iron pump required considerable machine equipment not then available and the stamped pump required new furnaces for the hydrogen brazing used to assemble the pieces. Considerable time would have been required to build the brazing furnaces. Sufficient machine equipment, however, was located in some of the plants to permit tooling for the cast iron pump bodies, therefore the cast iron unit was selected as the ultimate replacement for the die-cast fuel pumps.

### LEAD REPLACES ZINC FOR NON-STRUCTURAL PARTS

When General Motors was required to eliminate all their zinc base die-castings in order to save strategically valuable zinc, they found that non-structural parts, which were not required to carry any load, could be made satisfactorily from antimony lead die-castings. Such automotive parts as hood ornaments, instrument panel emblems and fender ornaments, were all converted this way.




*Two cast iron parts substituted for zinc did not impair quality of the carburetor*

### TWO UNIT ASSEMBLY REPLACES ZINC DIE-CASTING

Upper support for the Chevrolet gear shift control was originally a zinc die-casting. Dimensions could be held fairly close and the cast surfaces were smooth enough to give a luster finish when painted. To eliminate zinc, the company used a section of seamless or welded steel tubing, welded to a malleable iron section, and hammered or pressed to form. The malleable part is finish-machined and polished all over for painting before being welded to the tube. The production of this assembly is somewhat more complicated than that of the zinc die-casting, but is equally satisfactory in service and requires only readily available materials.

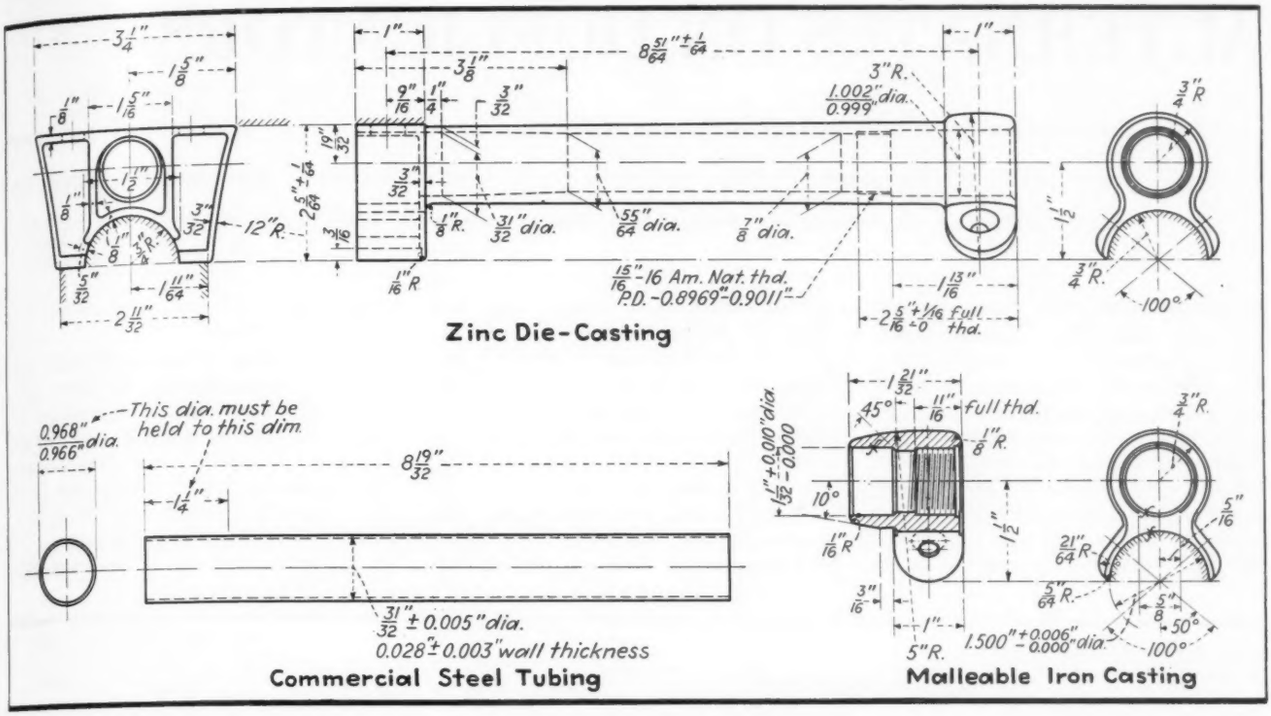
### PLASTIC COVERED STEEL HANDLES

Window regulator handles used in General Motors cars had always been made of zinc base die-castings. When zinc had to be eliminated, plastics seemed to be the logical solution, but, since plastic handles do not have sufficient strength at all temperatures, it was necessary to make steel inserts, weld them together and then mold the plastic around the steel. Although it is not practical to plate the plastic handles, it is possible to obtain interesting color combinations and save chromium.

Zinc die-cast interior door handles of General Motors cars, have also been replaced with handles made from simple steel stampings welded together and then covered with plastic materials in a molding operation.

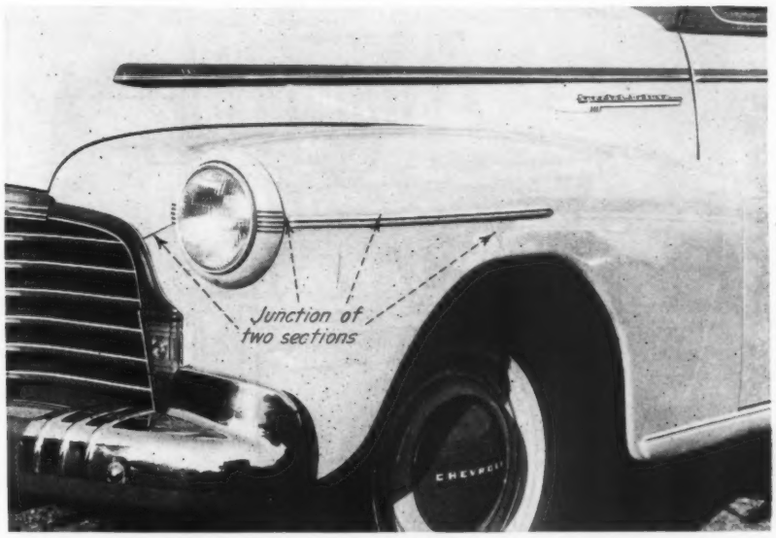
### CAST IRON CARBURETOR PARTS REPLACE ZINC

To eliminate strategically valuable zinc for their carburetors, the General Motors Corporation machined the two parts out of cast iron instead, although they retained the zinc die-cast venturi since the accuracy of this part determines fuel economy. While the cast iron pieces can be made to give the same performance as that obtained with the die-cast parts, much additional machining is necessary to produce the same surface finish. Some added manufacturing expense is, therefore, inevitable.

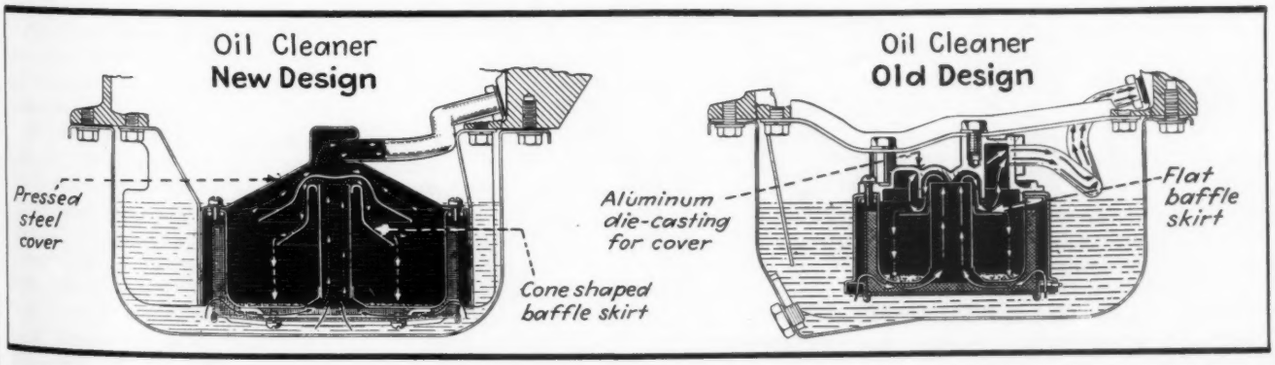



*A spot-welded assembly of the steel tube and iron casting adequately replaces the zinc die-cast support*

*The die-cast door handle is replaced by a plastic and steel assembly of fairly simple construction*




*This two-piece fender requires a simpler steel to make, saves strategically valuable aluminum and is equally pleasing to the eye*




*When this oil cleaner was redesigned to change the zinc die-cast cover to a steel stamping, the efficiency of the unit was improved*

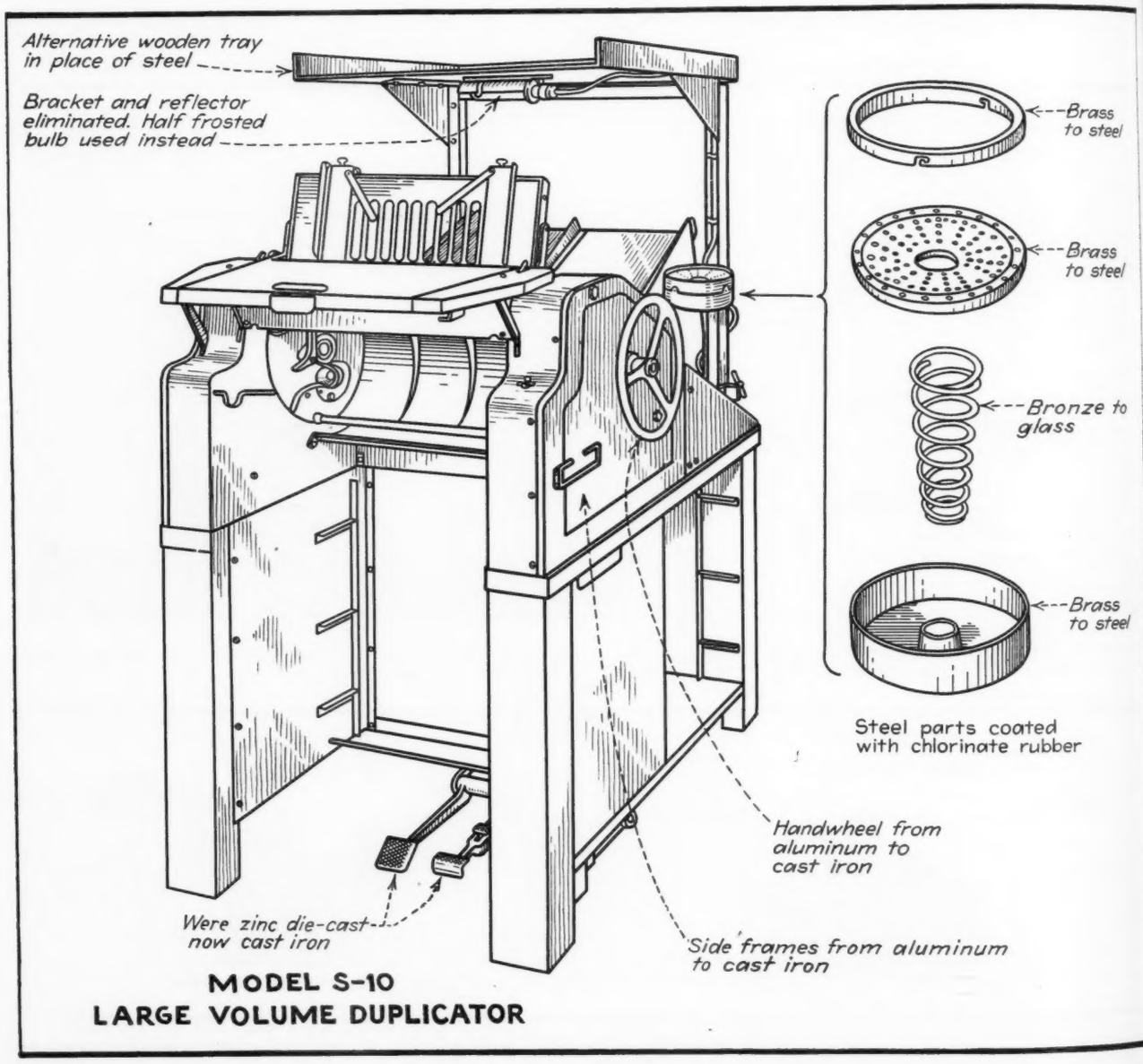
# ALTERNATES ON DUPLICATORS

**Substitution problems solved by Ditto, Inc. show possibilities for applications in many lines. Most of the more essential materials have been eliminated, and design changes in many parts are improvements which will remain when the emergency is over.**

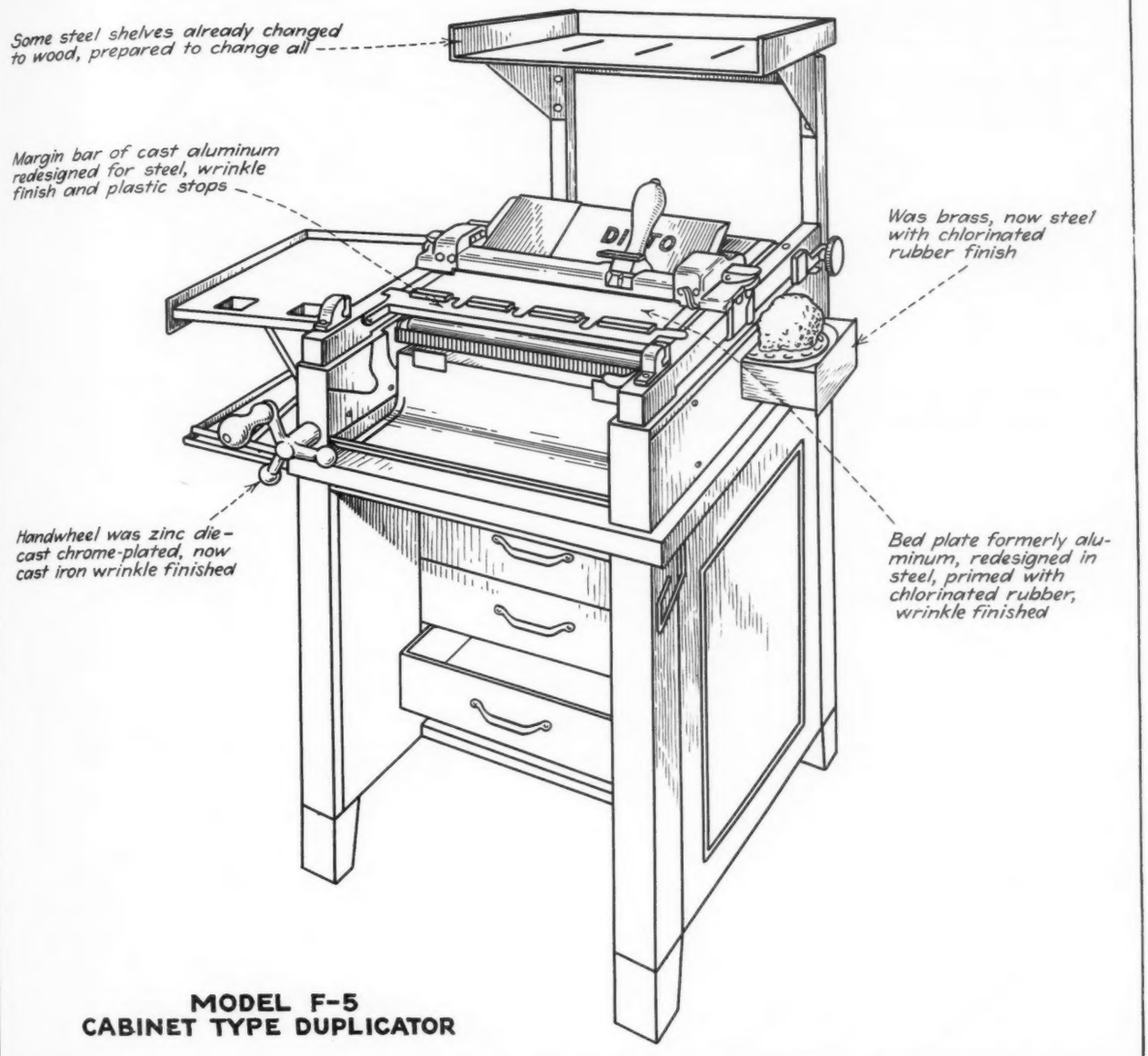
STAINLESS STEEL has been entirely eliminated from Ditto duplicating machines. Substitutes for stainless and other high nickel steels have included cold rolled, hot rolled steel (S.A.E. 6145), vanadium steel, straight chromium steel (S.A.E. 4140 and 52100) and drill rod (oil coated). Even though of limited application, nickel cast iron has been replaced by gray cast iron. Machine frames which were made of prime quality cold rolled steel and enameled, are now stamped out of auto body steel and wrinkle finished. A lock plate cam and roller, formerly oil die steel, are now annealed spring steel. Gears which were of S.A.E. 2340 are now 4615, or X 1335. Stainless tubing for gear spacers has been replaced by cold drawn butt weld steel tubing. For a zinc die-cast stop dog, the company is using Z metal on a test basis at present. Usually of steel, some shelves are now made of wood.

Even though all materials have not yet become inaccessible for Ditto, patterns and preparations for changes to cast iron have been made, and can be used at a moment's notice. Vendors are now given the choice of supplying parts of originally specified material or substitutes, whichever they can get.

By design analysis it has been pos-


Alternative wooden tray in place of steel
Bracket and reflector eliminated. Half frosted bulb used instead
Brass to steel
Brass to steel
Bronze to glass
Brass to steel
Steel parts coated with chlorinate rubber
Handwheel from aluminum to cast iron
Were zinc die-cast now cast iron
Side frames from aluminum to cast iron

**MODEL S-10**
**LARGE VOLUME DUPLICATOR**


Some steel shelves already changed to wood, prepared to change all
Margin bar of cast aluminum redesigned for steel, wrinkle finish and plastic stops
Was brass, now steel with chlorinated rubber finish
Handwheel was zinc die-cast chrome-plated, now cast iron wrinkle finished
Bed plate formerly aluminum, redesigned in steel, primed with chlorinated rubber, wrinkle finished
DITTO

**MODEL F-5**
**CABINET TYPE DUPLICATOR**

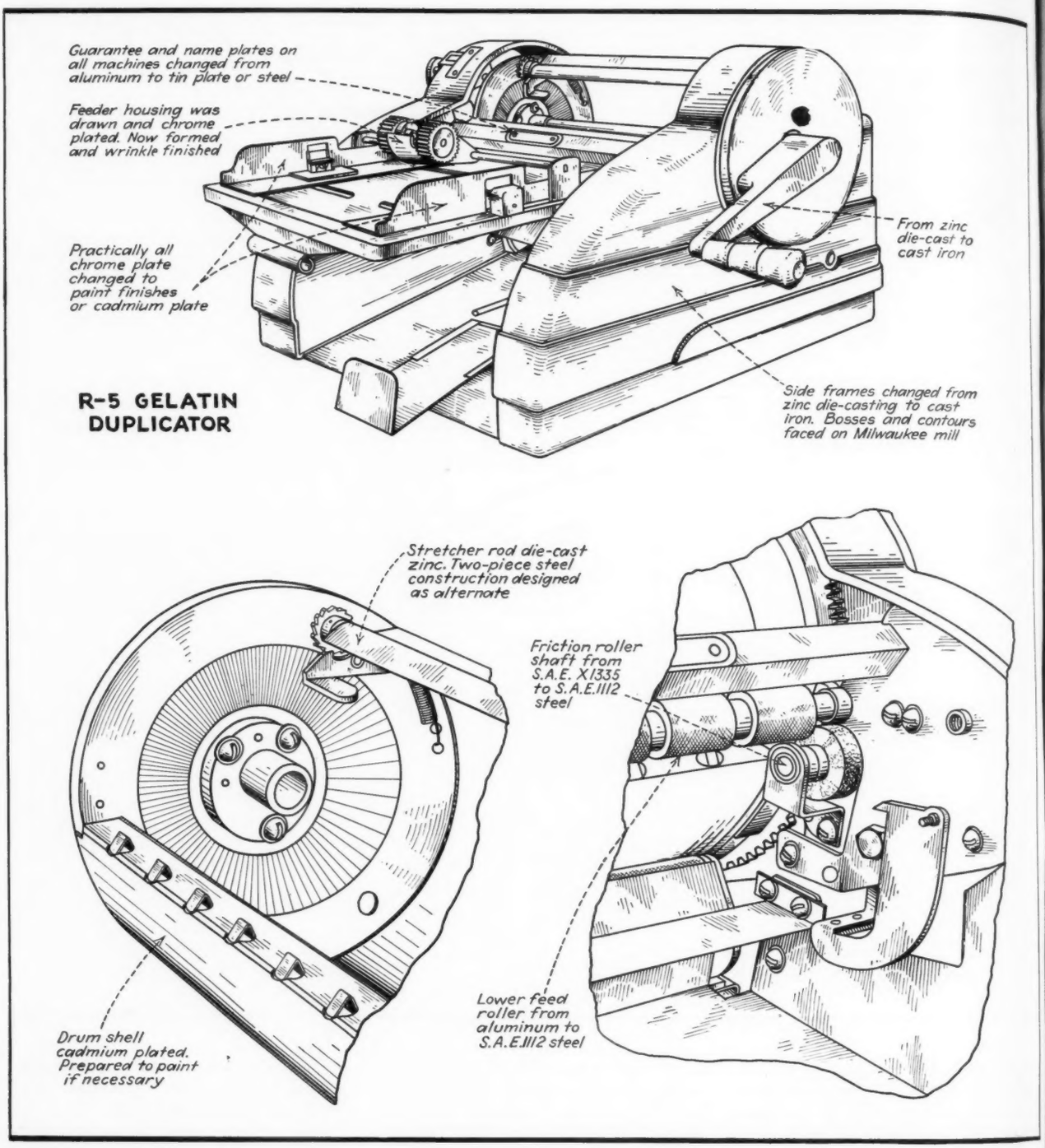
sible to eliminate some parts formerly considered essential. Designs have been changed and patterns made so that die-cast zinc parts can be converted to cast iron if it becomes a necessity.

Nearly all parts formerly aluminum are now cast iron. Cast iron can be substituted for all die-cast parts, and some such changes are now in effect.

Nickel and chrome plated parts have largely been replaced by cold rolled steel primer and finish painted, sometimes cadmium plated, and chrome plated brass acorn nuts have been eliminated in favor of standard steel hexagon nuts. Brass floats for reservoir tanks have been replaced by floats of latexed cork. Saran had been tested exhaustively as a substitute for brass and neoprene tubing and is now being used in many places on moistener and tank connections. (Cellulose base plastic tubing has not been found satisfactory for the purpose of carrying the fluid used in the Ditto process.) Water pans, formerly made of brass are now formed of steel plate and covered with chlorinated rubber. Cadmium finish for an inside plate subjected to water immersion was tried, for appearance sake, but chlorinated rubber proved much more rust resistant. The bronze spring inside the water pan may be replaced by a glass spring if bronze becomes entirely unavailable.

Replacement of large aluminum drums is definitely a problem. Plastics have been considered, but they are expensive and also difficult to get. Steel drums cannot be used because the machines were not designed to take care of the added weight. A possible solution, which has been considered, is the use of a wooden shell on cast iron ends, with a phenolic plastic shell as an alternate in the event that tests indicate trouble. Cast iron has been substituted for aluminum in side frames of the Systems Rotary, Ditto's high-speed systems machine.

Margin bar of the Model F-5 was cast aluminum and carried in stock in 16 models for different margin widths. Thumb notches were designed according to customer's specifications. This part is now cast iron, with molded plastic lugs, and supplied in four standard sizes with newly designed variable margins. Thumb notches have also been standardized into one satisfactory de-


Guarantee and name plates on all machines changed from aluminum to tin plate or steel
Feeder housing was drawn and chrome plated. Now formed and wrinkle finished
Practically all chrome plate changed to paint finishes or cadmium plate
From zinc die-cast to cast iron
Side frames changed from zinc die-casting to cast iron. Bosses and contours faced on Milwaukee mill
R-5 GELATIN DUPLICATOR
Stretcher rod die-cast zinc. Two-piece steel construction designed as alternate
Friction roller shaft from S.A.E. X1335 to S.A.E.1112 steel
Lower feed roller from aluminum to S.A.E.1112 steel
Drum shell cadmium plated. Prepared to paint if necessary

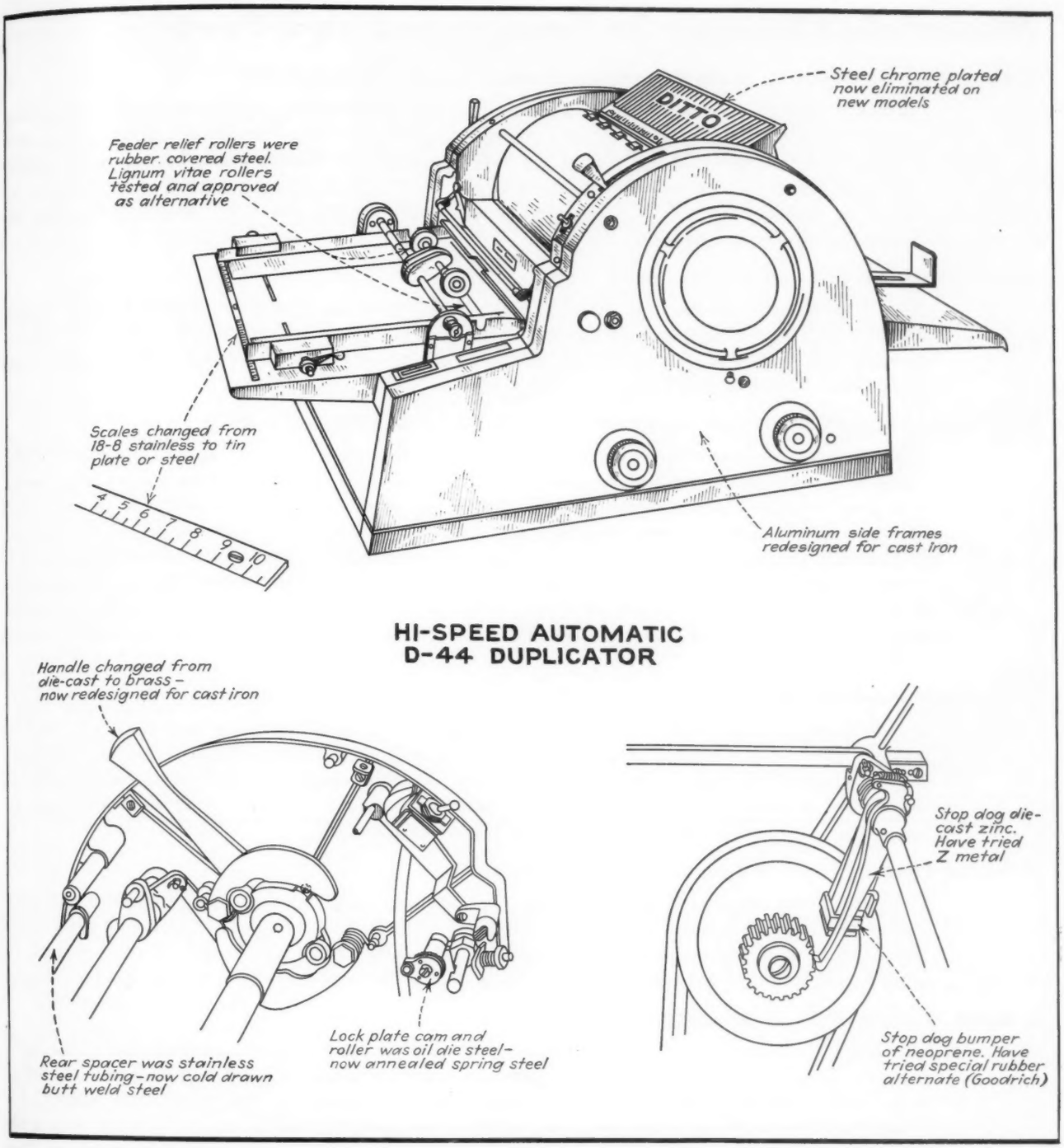
sign. Savings run from 80 cents to $3.00 depending upon the frequency of demand for the old parts.

Formerly of $\frac{1}{16}$-in. punched aluminum, the bed plate or platen on flat bed machines was padded on the underside with felt and cardboard to produce a thickness of $\frac{1}{8}$ in. Material now used is $\frac{1}{8}$-in. stretcher level steel stock. Ends are milled off where they were previously formed. Holes necessary to attach plates are drilled using the same tool as that used on aluminum. This steel plate is filled with chlorinated rubber primer, finished in wrinkle paint. Its use accomplishes a cost reduction.

A small chemical tank, which contains fluid used in the Ditto process, now made of soldered copper plate, may be made of soldered steel or terne plate. Welding is too expensive and too tricky for this job. Because of the soldered joints, a protective coating cannot be baked on. Lintite, an air drying paint, can be used when copper cannot be obtained.

Margin roller (beneath margin plate) now of steel, rubber covered, may be changed to steel covered with hard wood—birch or maple. Lignum vitae is being used to replace certain rubber rollers where tolerances are not fussy and the work performed is not too critical. The wood rollers are used in porous, oil impregnated bearings.

Shrinkage of this wood was a problem until the engineering department evolved a process of dimension control. Rollers so treated have shown no wear after 250 hours service, and the shrinkage is not so great as to impair their usefulness. The most successful method


Steel chrome plated now eliminated on new models
Feeder relief rollers were rubber covered steel. Lignum vitae rollers tested and approved as alternative
Scales changed from 18-8 stainless to tin plate or steel
Aluminum side frames redesigned for cast iron
HI-SPEED AUTOMATIC
D-44 DUPLICATOR
Handle changed from die-cast to brass – now redesigned for cast iron
Rear spacer was stainless steel tubing – now cold drawn butt weld steel
Lock plate cam and roller was oil die steel – now annealed spring steel
Stop dog die-cast zinc. Have tried Z metal
Stop dog bumper of neoprene. Have tried special rubber alternate (Goodrich)

to date has been soaking in Lignotite, the procedure for which follows: (1) soak for 10 minutes; (2) dry for two days; (3) rough machine; (4) dry for 1½ days; (5) finish machine.

Other systems, such as finish machining after two days drying, did not result in constant enough shrinkages so that final dimensions could be obtained within suitable limits.

It is anticipated that neoprene will disappear from civilian use. Hycar has taken its place in many cases. Leather and felt are being tried in place of rubber stops and feet where amount of resiliency is not a factor.

For finishes, this company is using cadmium plating, a large quantity of green wrinkle paint and aluminum solvent paint. A substitute for the latter is on hand in the event of a shortage. By eliminating the chrome finish on carriage ends of flat bed machines and substituting wrinkle finish, sanding and buffing operations were eliminated and the finishing cost reduced by 50 percent.

Concerning paint finishes, H. Jagger, assistant chief engineer has said that where prime quality steel is no longer obtainable and it is necessary to go to a lower grade, proper selection of a finish not only provides as good an appearance as baked enamel formerly used, but actually can better it.

Chromium plated and stainless steel nameplates, guarantee plates, and scales, are now made of etched steel or tin plate.

Dies are now being made for the use, in event of difficulties, of cellulose acetate knobs and handles as an alternative to the die-cast zinc now used.

# Materials Changes in Equipment and Parts

### 1. FROM BALL BEARINGS TO NEEDLE BEARINGS WITHOUT CHANGING MOUNTINGS

NEEDLE BEARINGS have been used in place of standard ball bearings by a paper machinery manufacturer for certain smaller bearing applications with light loads, such as sheave mountings. Reason: deliveries of standard ball bearings could not be made for three to six months, whereas needle bearings were available from stock. Bearing bore and size requirements were met without altering machining specifications by pressing a sleeve over the shaft, or by pressing the needle bearing race into a bushing which then was pressed into the machine housing.

### 2. SHEAVES MADE OF LIGNUM VITAE INSTEAD OF CAST IRON

SHEAVE PULLEY for window sash cord, formerly made of cast iron, is now turned from wood by the Lignum Vitae Company. Cast pulley had a cored square hole through hub into which a piece of wood was pressed. The wood insert was drilled for a running fit on pin held in sheave box. Pulley of new design is machined from a stick of lignum vitae.

### 3. CHANGING FROM BRASS TO CAST IRON REQUIRED REDESIGN FOR WEIGHT BALANCE

CAM AND SECTOR ASSEMBLY of Toledo scales were formerly made of cast red brass. The location of the center of gravity and the radii of the machined surfaces had been carefully predetermined for this design. Cast iron was chosen to replace the brass, but the lighter weight of the cast iron shifted the center of gravity when the same patterns were used. Therefore, more material had to be added to the sectors to restore the center of gravity to its original position. Iron was added where additional material was needed so as to put the center of gravity in its original position without disturbing the sector arcs. The cast iron machined surfaces, on which the steel ribbons bear, are cadmium or zinc plated. In the illustration the original brass cam and sector is shown to the left, the trial redesign of cast iron in the center, and the final design to the right.

### 4. IRON PIPE FITTINGS SERVING IN PLACE OF ALUMINUM CASTINGS

A COMPANY MANUFACTURING smoke detection equipment, electronic counters and other such devices, was accustomed to using cast aluminum housings for their light sources. With aluminum unavailable, they investigated all other possibilities and decided on these simple iron-pipe fittings which, although not light or decorative, are nevertheless cheap and easily obtained, and have an appropriately functional appearance. The exterior surfaces are given a black wrinkle finish.

### 5. WHERE CAST IRON IN PLACE OF LEAD SERVES JUST AS WELL

ON LARGE TRUCK SCALES and scales of similar type, the counterweight boxes must be weighted to counterbalance the scale at no load. Customarily, the boxes were filled with lead shot. To avoid the use of lead the Toledo Scale Company has changed to cast iron "biscuits," which are stacked in the box until the scale arm is almost in balance. Fine steel shot is then added until exact balance at no load is obtained.

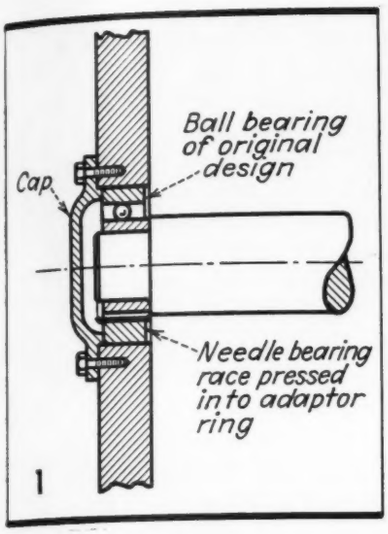
### 6. SCREW MACHINE PART REDESIGNED FOR STEEL

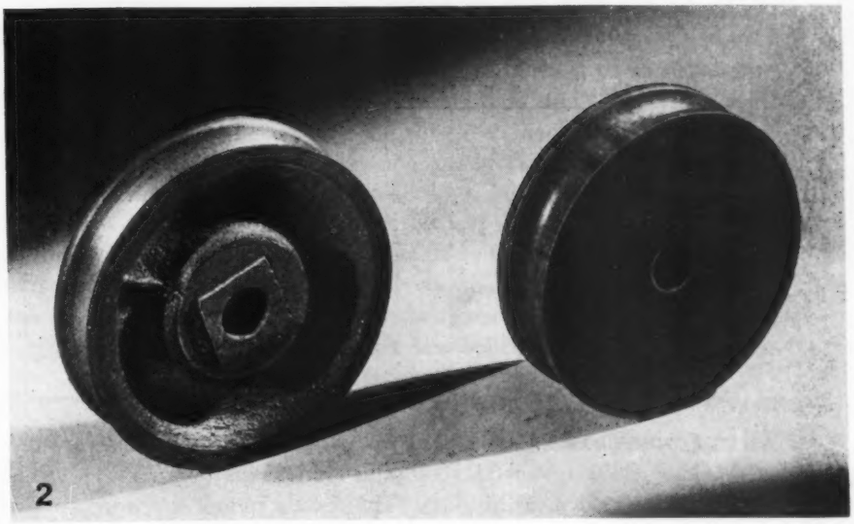
SCREW MACHINE PRODUCTION is slowed appreciably when changing from brass to steel stock. This makes it highly desirable to redesign the part so as to minimize the volume of metal to be removed. The differences between the stock diameter and the stepped diameters should be kept minimum, lengths of machined sections should be a minimum, and drilling and boring should be reduced as much as possible. Typical example is knob of auto accessory, changed from brass to steel without altering appearance. Brass knob was formerly hollowed out because of high scrap value of metal thus recovered.

### 7. FROM BRASS TO CAST IRON WITH STEEL INSERT

TO ELIMINATE BRASS from counterpoises, the Toledo Scale Company changed them to iron. The poises originally were brass castings with a chrome finish, and were brought to proper weight by loading with lead. The two halves of the poise were cast as a pair in plaster molds and were not interchangeable with other poise sections. A sharp pointer edge was obtainable directly from the casting.

The cast iron poise was a sand casting, and since comparable accuracy is impossible with sand, unsightly mismatching of the two halves was made unnoticeable by a bead running around the inner edge of the rear half. All poise sections are now interchangeable. The poises are Bonderized and then given a black baked enamel finish. To prevent wear of the cast iron against the steel beam on which the poise rides, a hardened steel insert, which also serves as a sharp edged pointer, is used.


Ball bearing of original design
Cap
Needle bearing race pressed into adaptor ring
1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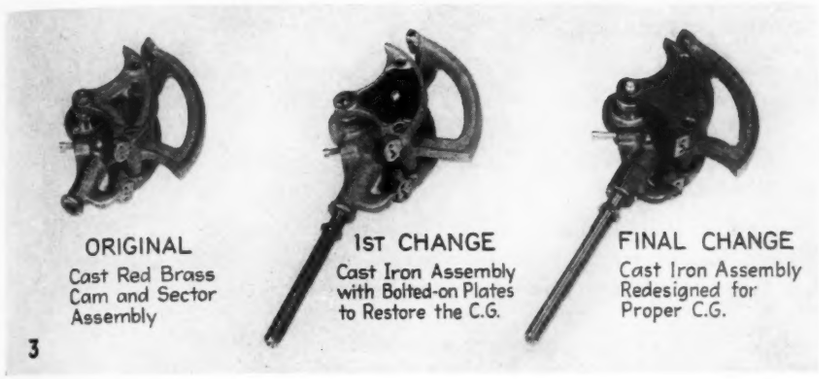
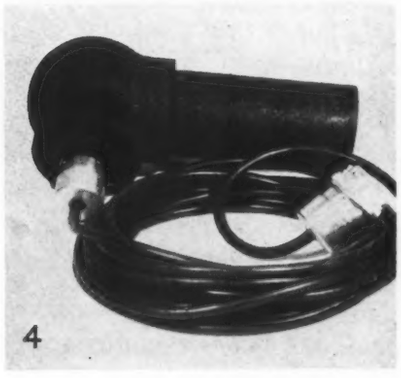

ORIGINAL
Cast Red Brass Cam and Sector Assembly
1ST CHANGE
Cast Iron Assembly with Bolted-on Plates to Restore the C.G.
FINAL CHANGE
Cast Iron Assembly Redesigned for Proper C.G.
3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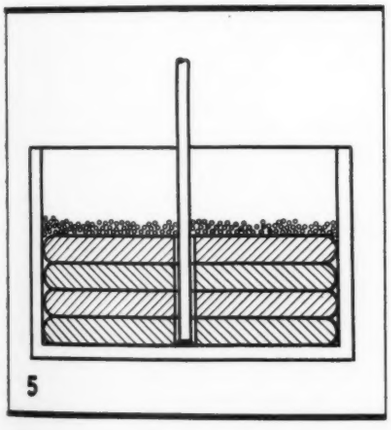
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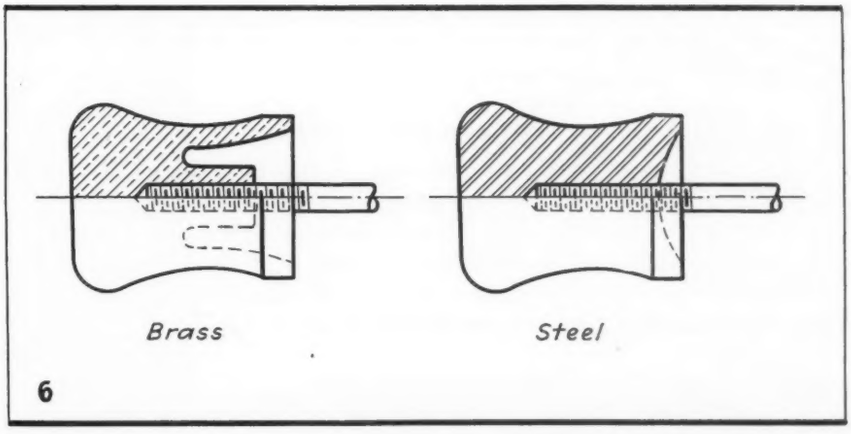
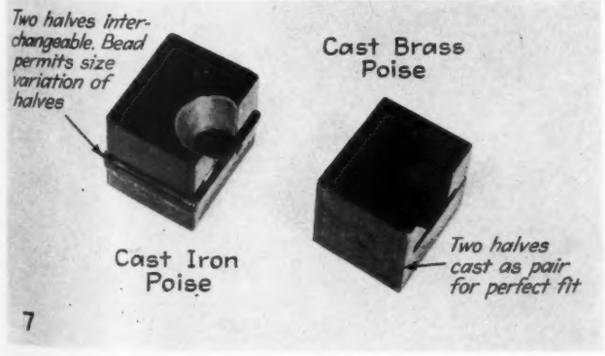
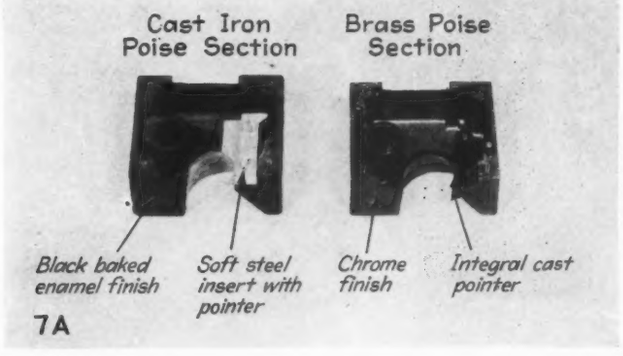

Brass
Steel
6


Two halves interchangeable. Bead permits size variation of halves
Cast Brass Poise
Cast Iron Poise
Two halves cast as pair for perfect fit
7


Cast Iron Poise Section
Brass Poise Section
Black baked enamel finish
Soft steel insert with pointer
Chrome finish
Integral cast pointer
7A

### 9. DIE-CAST KNOBS NOW FORMED SHEET STEEL

CHROME-PLATED ZINC DIE-CAST KNOB used on Bailey Meter panels for auto-control selector valve has been redesigned as an assembly of two stampings and a screw machine part. The cap is stamped out of $\frac{1}{32}$ in. thick sheet steel; hub shell stamping is out of sheet steel $\frac{1}{16}$ in. thick. Hub insert is cold rolled steel screw machine product. Parts are press-fit and clinched assembled in a punch press. Knurling on cap is produced by pressing a rubber plug inside cap to force the metal outward between ridges in walls of die. Knurling thus formed is easier on hands than old type. Hub shell is formed in three draws from a 4 in. dia. blank and then pierced. 9A—Zinc die-cast arrow shaped knob on Bailey Meter panel has been replaced by a triangular steel stamping with washer and small steel bar inserts for shaft attachment. The stamping is made in two draws, the second forming the round part that holds the washer. Washer and bar are assembled by brazing, after which shaft hole is drilled in bar and assembly is brazed into knob shell. Setscrew hole is drilled and tapped after assembly.

### 10. ONE-PIECE GLASS LAMP BODY AND LENS

WHEN FORD ENGINEERS redesigned the parking lamp for Ford cars they not only eliminated all the steel in the lamp housing but also simplified the manufacturing. The whole parking light housing including the lens is a single piece of glass. With the exception of the interior surface of the lens the glass interior is coated with an opaque metallic paint.

### 10A. SHEET STEEL STAMPINGS REPLACE DIE-CASTINGS

MOTOR CAP of Premier tank type vacuum cleaner was formerly die-cast, is now stamped from 0.042 in. thick sheet steel. Brush holder frame formerly integral with cap is now a separate stamping with spot welded straps.

### 11. MOLDED PLASTICS SUBSTITUTED FOR DIE-CASTINGS

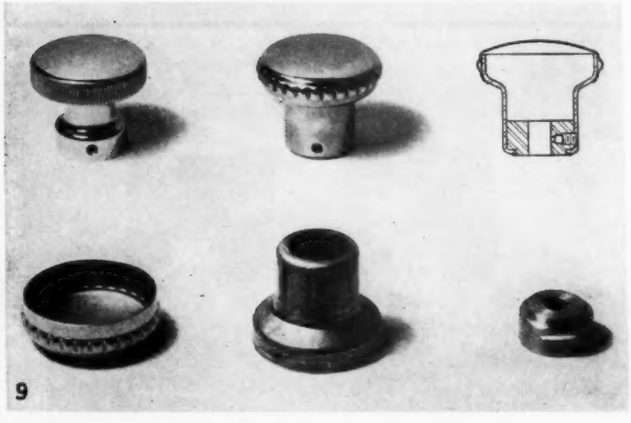
WHEN ZINC DIE-CASTING ALLOY became scarce, Delta Manufacturing Company changed to phenolic plastics for their micro miter-gage head and locking knob, 11A. Threads are molded in. Previously both parts were zinc alloy; head was black lacquered. Plastic molded unit is lighter in weight.

### 12. FIBRE TUBES FINDING MANY NEW USES

CHROMIUM-PLATED BRASS TUBES of A. C. Gilbert toy microscope have given way to fibre tubes. Chief problem in redesign was rigid specification of tolerances on tube diameters. As shown at 12A, die-cast ends are pressed into place, and small tube must be easy sliding fit inside die-casting at top of large tube. Because the fibre's appearance is more easily spoiled by scratches, burrs must be removed from die-castings.

### 13. STEEL KNIFE BLADE NOW MOLDED PLASTIC

THE SHEETROCK JOINT KNIFE distributed by the U. S. Gypsum Company was formerly made of steel with a riveted wooden handle. It is used in joining wallboard panels with special adhesive perforated tape. Trying plastics, this company found it possible to make blade and handle out of a single molding of Lumarith, a cellulose acetate material produced by Celanese Celluloid Corporation. The resultant knife has the flexibility and smoothness required for the job, its weight is 75 percent less than the steel knife it replaces and it costs only one-fourth as much.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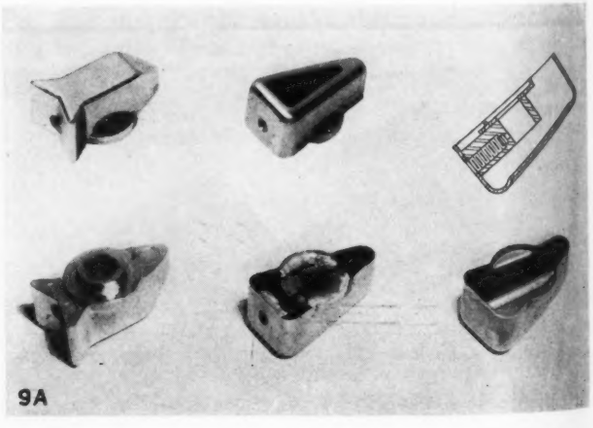
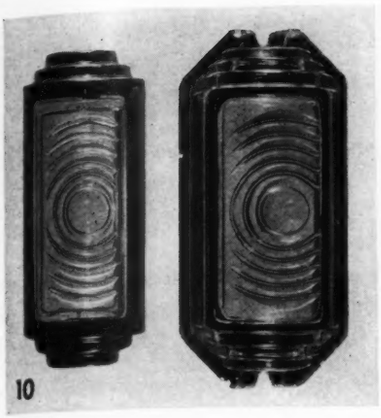

9A



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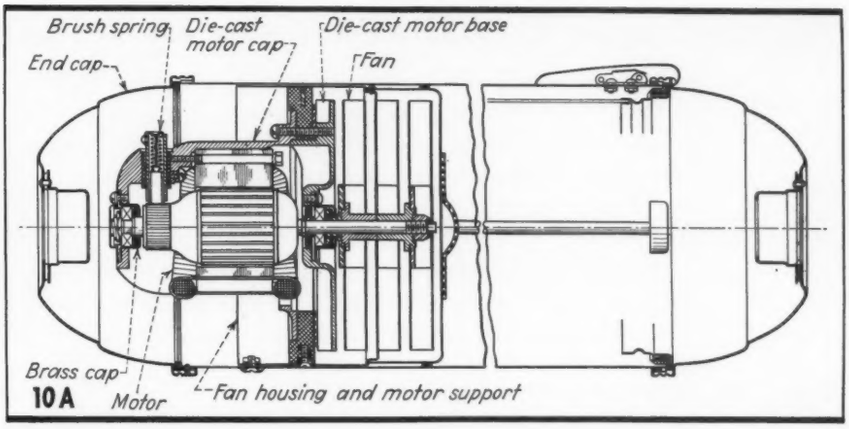
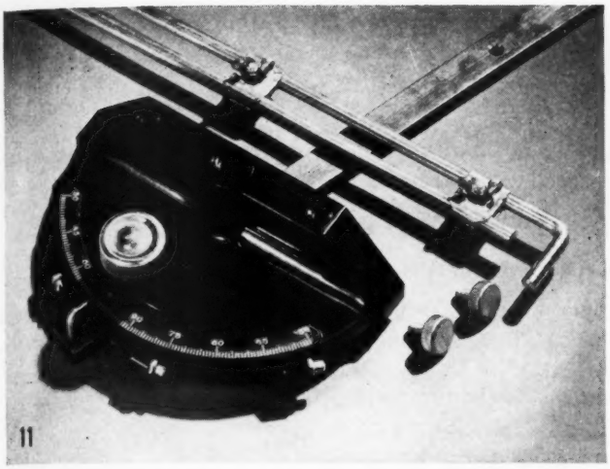



10 A



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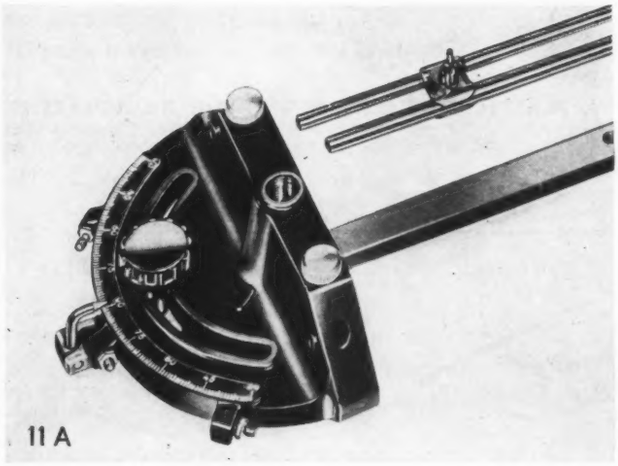
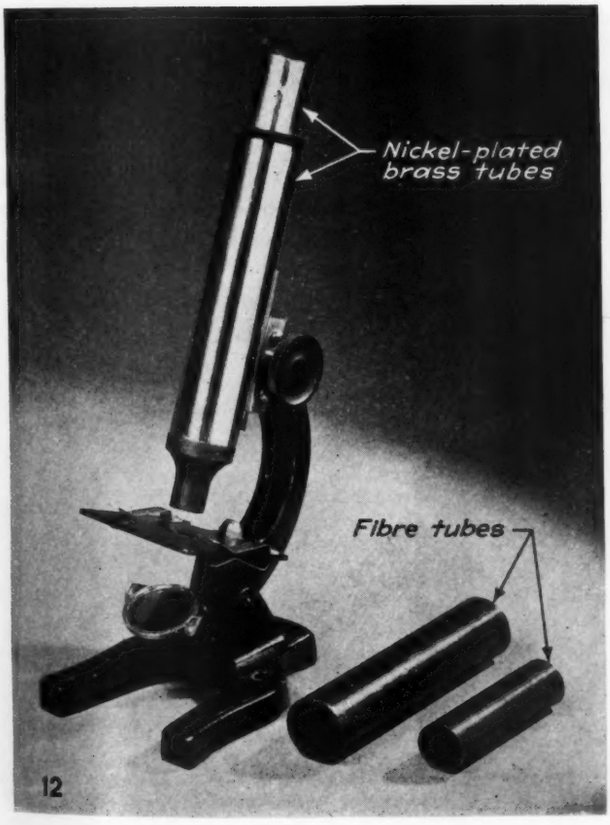
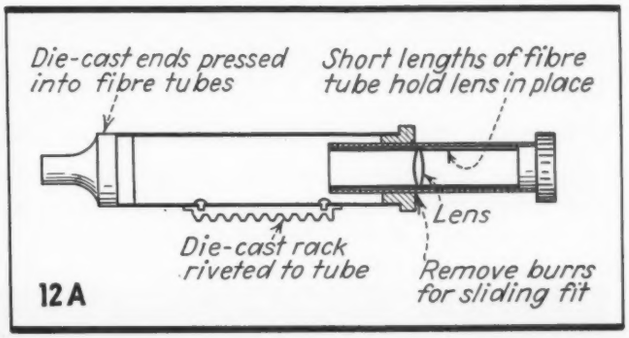


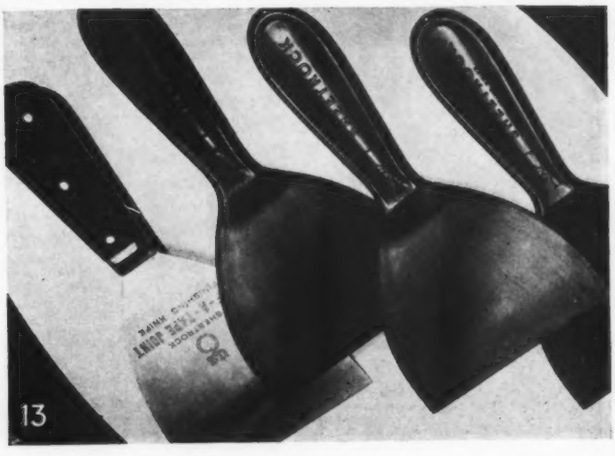
11 A




12


Die-cast ends pressed into fibre tubes
Short lengths of fibre tube hold lens in place
Lens
Die-cast rack riveted to tube
Remove burrs for sliding fit

12 A



13

# Significant Replacements by Plastics

**1. EXTRUDED PLASTICS FOR TRIM**

FINDING COPPER, BRASS OR MONEL METAL SCARCE, one company finished its new cabinet-sink design with Plastiktrim around the edge of all the working surfaces.

**2. CELLULOSE ACETATE FOR STAMPINGS AND CASTINGS**

WHEN METALS AND METALLIC FINISHES became scarce the Norge refrigerator manufacturers swung to plastics, using cellulose acetate in place of steel stampings, zinc die-castings, chrome and enamel plating, variously required in the parts shown. Plastic has a definite advantage where rusting is a factor.

**3. PLASTIC DIALS AND KNOBS FOR AIRCRAFT**

AIRCRAFT KNOBS AND DIALS molded of plastics release strategic engraved metals, weigh only half as much and for dials give better visibility and permanence to the markings. Knobs are injection molded of clear cellulose acetate butyrate; hubs are molded-in inserts. Characters are indented in rear surface. Characters are coated with a fluorescent material that glows when exposed to ultra-violet light.

**4. PLASTIC REPLACES METAL FOR NAMEPLATES**

WITH COPPER, TIN AND ZINC becoming scarce, the manufacturers of the Norge refrigerator abandoned the usual chrome-plated metal nameplate. The redesigned nameplate is made of a copper-bronze colored cellulose-acetate molding of Lumarith, molded by the Erie Resistor Company for Norge.

**5. POLISHED STEEL WITH PROTECTIVE COATING REPLACES CHROMIUM**

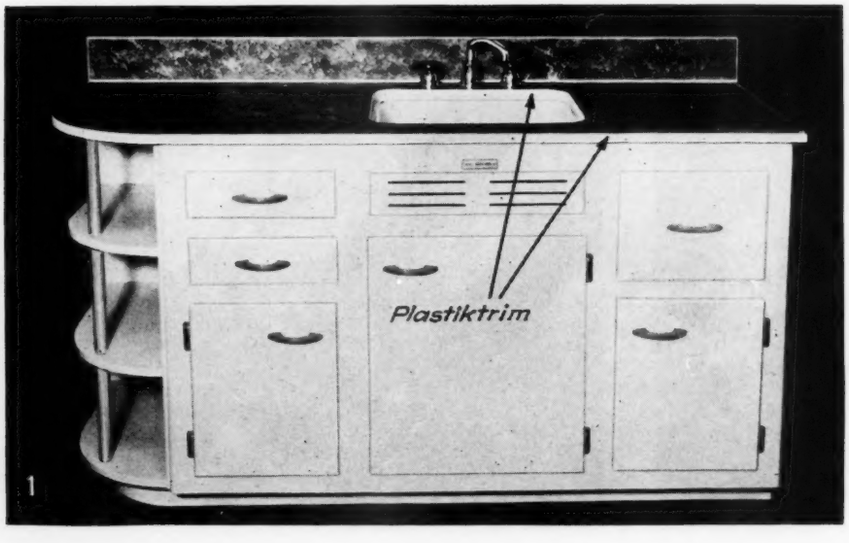
THE HORN RING SHOWN is not plated with chromium. Finding chromium unavailable, the Hudson Motor Car Company hit upon another satisfactory solution of the problem. This horn ring is made of a steel stamping, highly polished, with a baked-on clear invisible plastic coating. It is believed to be fully satisfactory for interior trim.

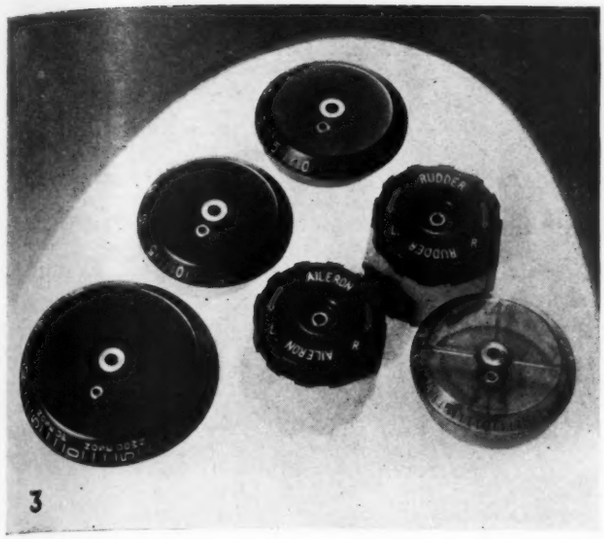
**6. TRANSPARENT MOLDING PAINTED ON BACK, MAKES COLORFUL DESIGN**

CRYSTAL CLEAR MOLDED PLASTICS combined with colorful paint produces this serviceable and attractive horn button which is a substitute for the usual nickel or chrome finished metal unit. Injection molded of Lucite by the Erie Resistor Corporation Plastics Division, the button is so designed that the lettering and designs stand out in three dimensional relief from the multi-colored background.

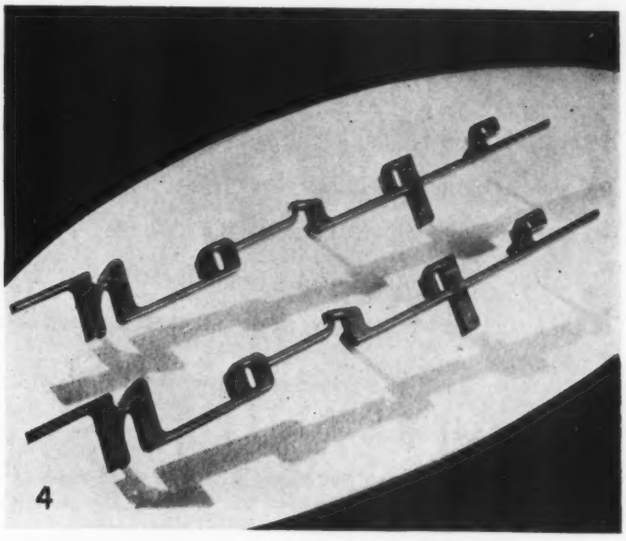
**7. PHENOLIC RESIN REPLACES HARD RUBBER INSULATOR BLOCK**

PLASTICS ARE NATURAL ALTERNATES for hard rubber in most electrical parts. Insulator block for heater connection of packaging machine is typical example. Linen base laminated phenolic resin was selected in place of hard rubber. Reason: good insulating properties, excellent machineability, high strength.

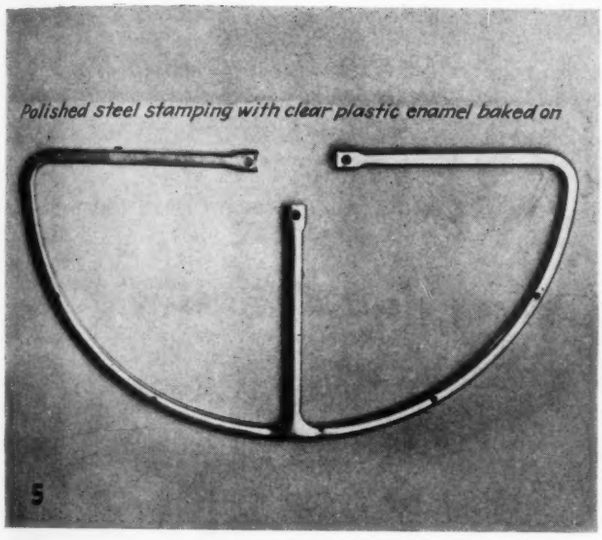



RUDDER
AILERON

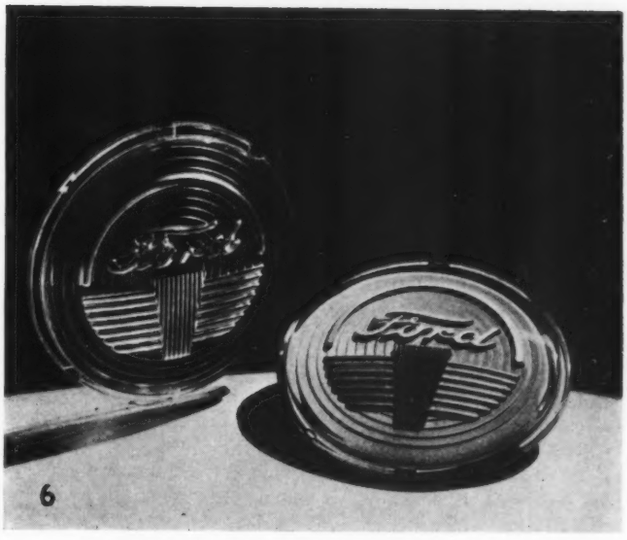
3


norge
norge

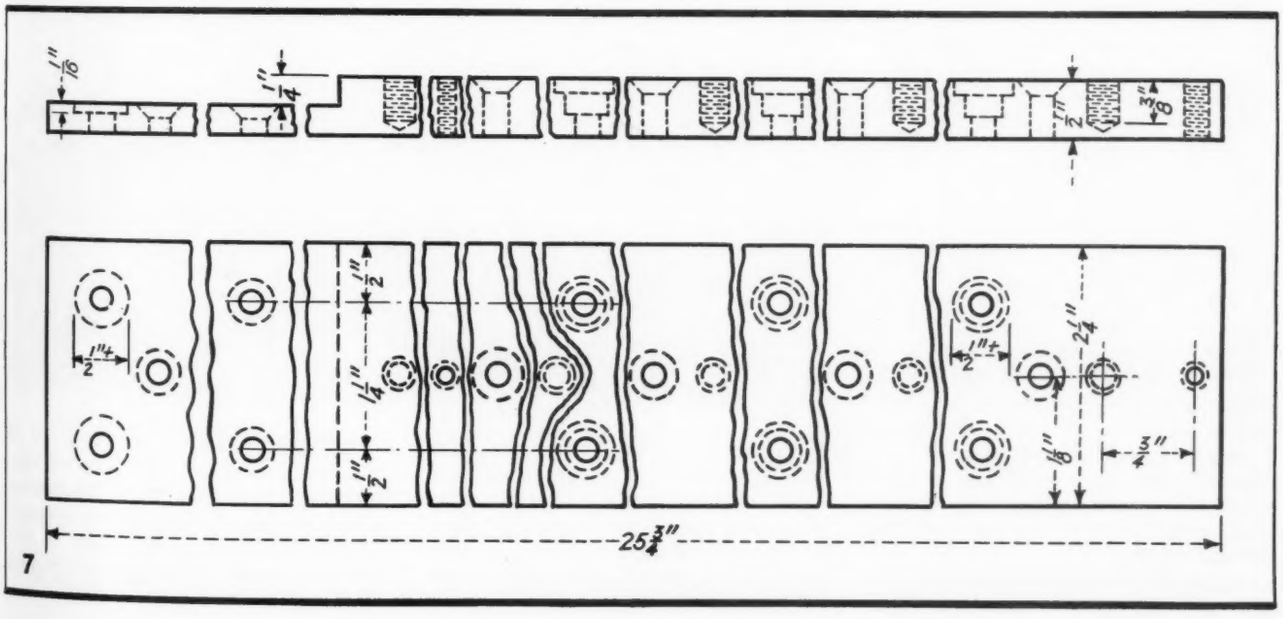
4


Polished steel stamping with clear plastic enamel baked on

5


Ford

6


1/16"
1/4"
1/2"
3/8"
1/2"
1 1/4"
1/2"
1 1/4"
1/2"
2 1/4"
1/8"
3/4"
25 3/4"

7

# REDESIGNS OF SMALL PARTS

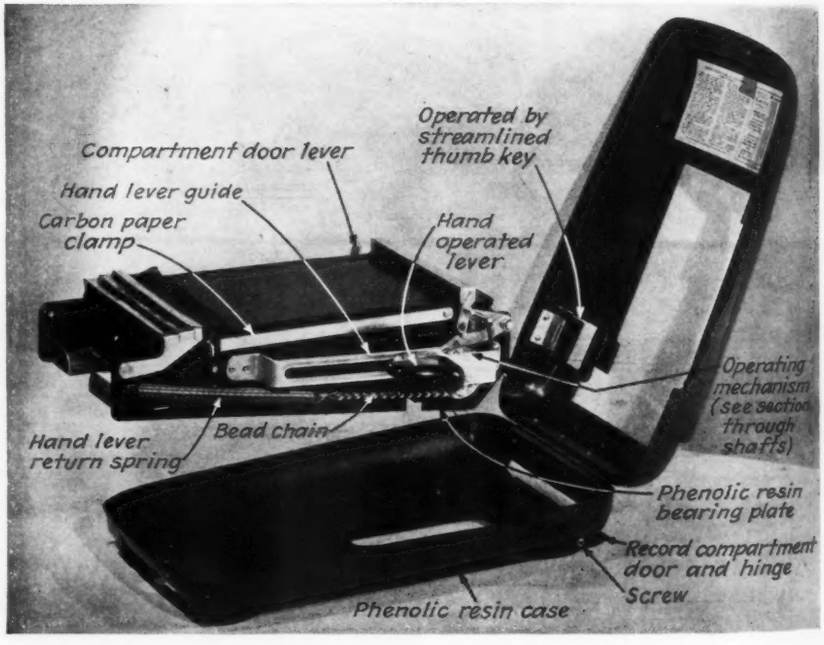
Principal requirements for materials used in instruments, meters and small mechanisms are good corrosion resistance, accurate machining properties, dimensional stability, and light weight for portable equipment. To meet these requirements, aluminum, brass and zinc alloys have been used extensively, and alloy steels have been chosen for parts where high strength or wear resistance is desired. Examples in this section show how these strategic materials have been eliminated by:

1. Brazing small alloy steel and plain steel pieces to form parts that were previously all alloy steel
2. Using welded, brazed, or soldered sheet steel construction in place of forged or cast brass and aluminum alloys
3. Substituting free-machining steel screw stock for brass
4. Specifying plastics in place of aluminum or zinc alloy die-castings
5. Substituting sheet steel or plastics for aluminum in housings
6. Making mechanisms simpler, more compact, requiring fewer parts
7. Substituting chemical finishes, wrinkle finish, baked enamel, or cadmium plating for stainless steel, polished aluminum, or electroplated corrosion-resistant finishes

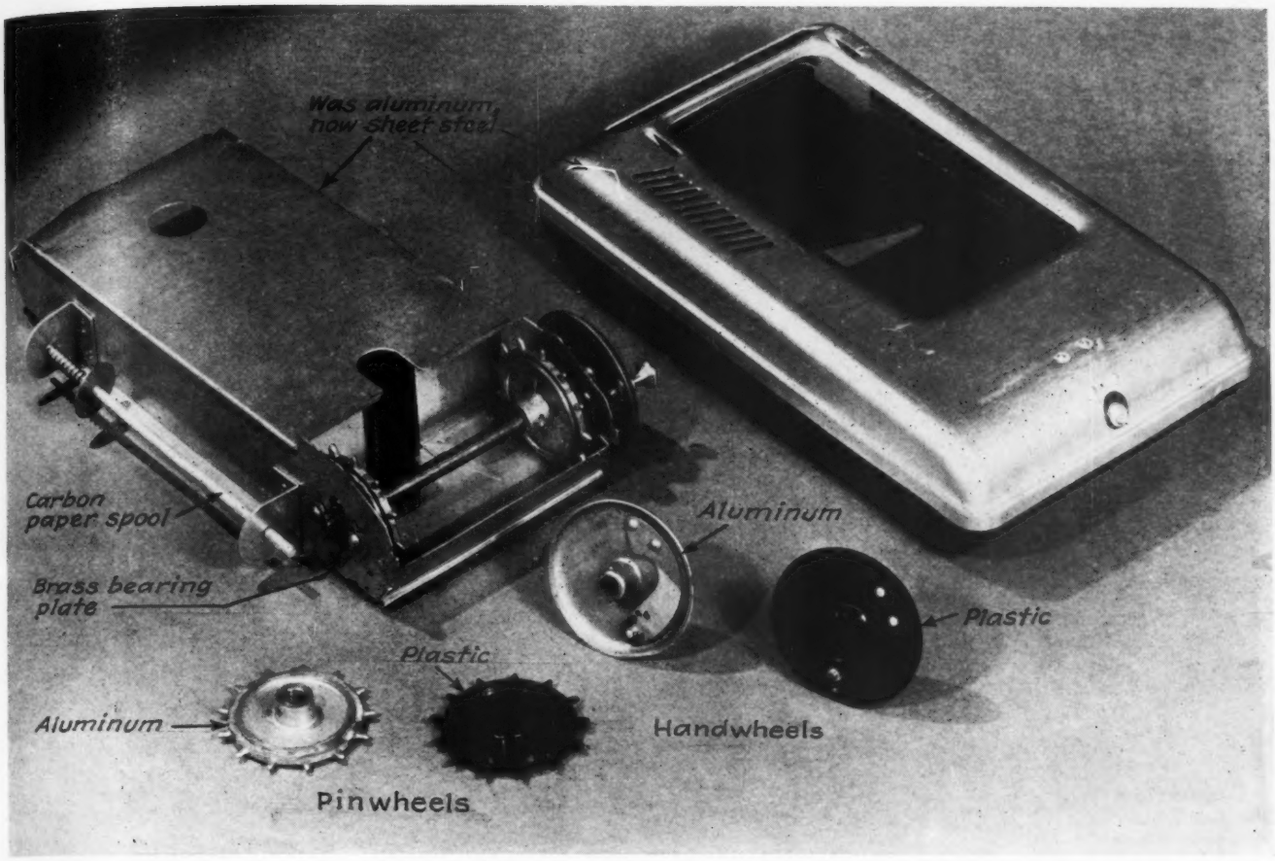
## Register Now Made of Steel and Plastics

**Complete redesign** was done by Standard Register Company on a new hand and desk model register for fabrication in sheet steel and plastics instead of aluminum, zinc, and brass. The operating lever knob, shown in its normally locked position, is released by lifting. This (1) lifts a holding latch from a slot of disk pinned to drive shaft, (2) releases the latch retaining tear guide bar from its holding position, (3) lifts latter to permit flow of multiple forms, and (4) allows knob to be pulled toward operator, thus ejecting multiple form sheets. A pull on knob along guide slots rotates drive shaft, which is geared to pin-wheel shaft, by means of bead chain around sheave the side walls of which are shaped to prevent slipping. Standard chain-end saddles are hooked over a projection on lever guide pin at one end and at the other to end of spring, as shown. Sheave and disk, to which it is copper hydrogen brazed, rotate loosely on drive shaft on return stroke of knob. Shaft is driven by spring-held pawl on this disk and engages a cam. Cam is pinned to drive shaft with previously described slotted locking disk as shown by sectional view through shafts.

Deserving of particular attention are the phenolic plastic bearing plates which replace brass plates in older models. These 2 x ¾ in. plates are ⅛ in. thick and have grooves in their edges into which the sheet steel edges of the frame slide and hold it in position. Brass plates in older models are held in position by two bolts.




Redesign of forms to enable use of reduced sizes is another form of conservation accompanying mechanical and materials changes. In one instance 11 miles of paper and 9 miles of carbon were saved for a company writing 50,000 six-part invoices a year.

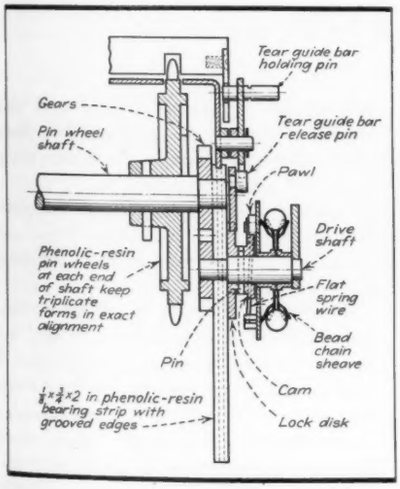



**Register cabinets** have been stamped out of sheet aluminum and much of the interior mechanism has also been aluminum. Now most models are being made of sheet steel stampings, the top having a smooth black finish and the bottom painted a black wrinkle finish. No change in forming dies was needed. These cabinets are produced at lowered cost and considerable saving was effected by reducing the number of current models 50 percent.

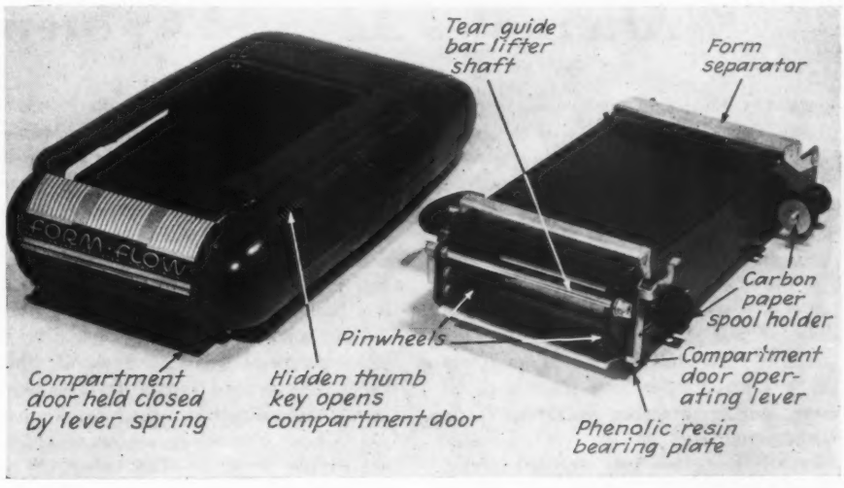
Pinwheels, a feature of Standard Register Company's line of registers for positive alignment of multiple forms and carbon papers, have been made of zinc die-castings. Recently these wheels were changed to black phenolic resin plastic. They are produced by the transfer molding process.

Similarly the handwheel, which is turned to release multiple orders or other forms from the smaller registers, was changed to phenolic resin from nickel plated zinc die-casting, with considerable improvement in the part. A steel handle is used as before and is attached to a leaf spring on the under side through a hole in the disk. This spring is attached by drive screws.

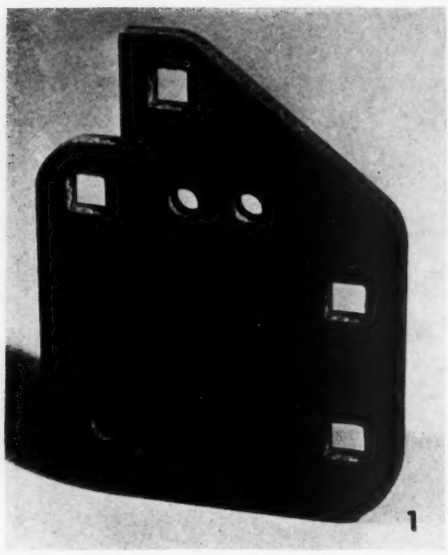
Use of the so-called chemical blacks has been made where chromium plated parts were eliminated.

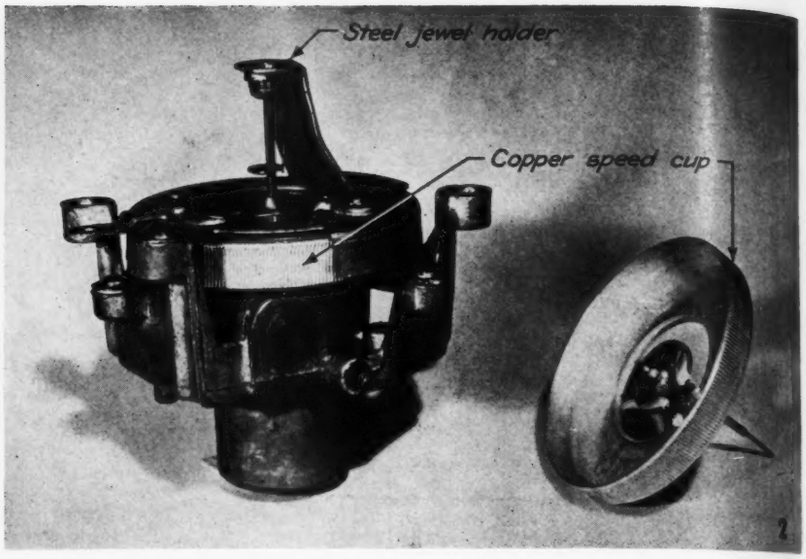

Tear guide bar holding pin
Gears
Pin wheel shaft
Tear guide bar release pin
Pawl
Drive shaft
Phenolic-resin pin wheels at each end of shaft keep triplicate forms in exact alignment
Flat spring wire
Bead chain sheave
Pin
Cam
1/8 x 1/4 x 2 in phenolic-resin bearing strip with grooved edges
Lock disk

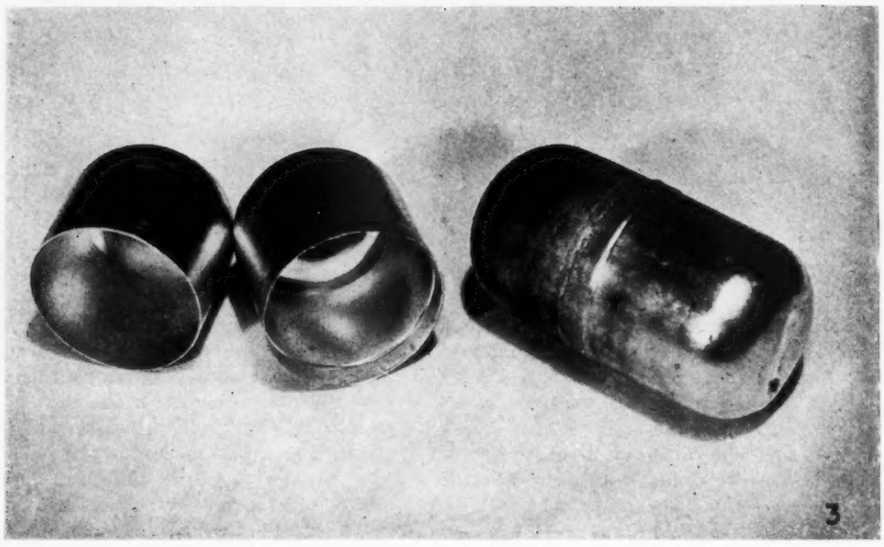
**Cross-sectional view** through register drive and pinwheel shafts shows operating mechanism details.

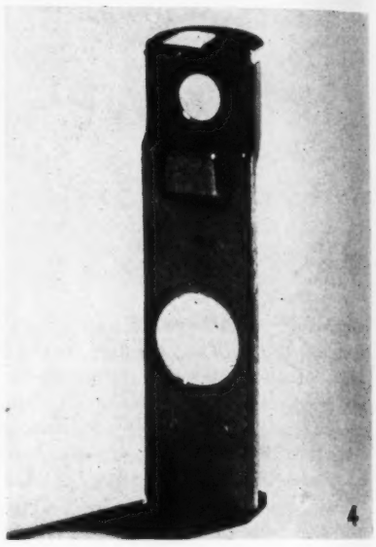



**Among the convenience features** of Standard's new register are improved carbon paper spool holding device and hidden thumb lever which opens bottom compartment to receive permanent record copies of forms after removal.







# Alternates Adopted by Stewart-Warner

STEWART-WARNER ENGINEERS have eliminated 30 percent or more of the brass and copper and all aluminum from gages, fuel pumps, speedometers, tachometers, windshield wipers and such drive equipment as flexible shafts and gear boxes.

Copper, brass and aluminum have been 100 percent eliminated from car heaters and Alemite equipment. With steel or cast iron substituted for about 50 heater parts, service is as good as ever. Where corrosion resistance is desired, cast iron or steel is cadmium plated. In place of copper tubing, Bundy-rolled and lapped steel tubing (Bundy Tubing Co.) is used. For their applications, it bends and flares without difficulty.

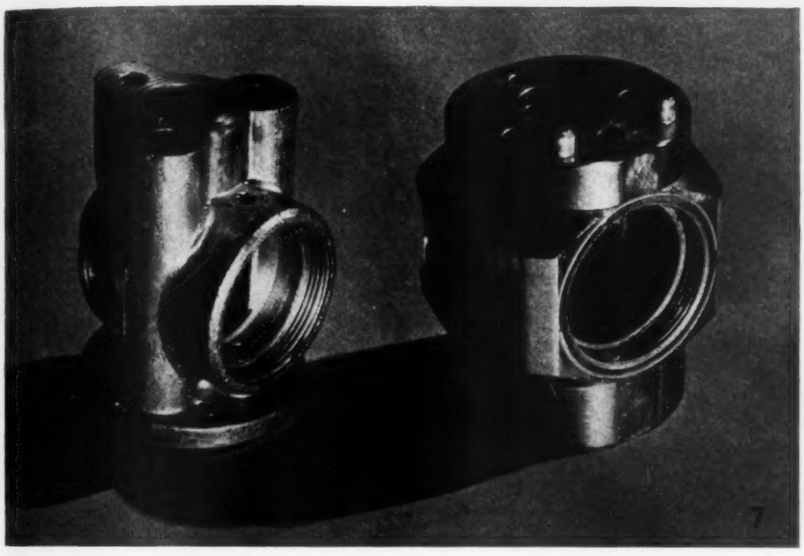
Formerly, chromium plated, brass, stainless steel or aluminum nameplates are now decalcomanias or painted cold rolled steel. Since it has been necessary to make steel dies for stamping, they will probably be kept and stamped steel nameplates be continued after the emergency period. The main reason for using brass was the lower cost of dies.

For some small parts usually of phenolic resin plastic, a wood fibre substitute is used today. It is worked in the same dies but must be sanded to size when other than standard thicknesses are required. The substitute is hygroscopic and requires wax impregnation to make it more moisture resistant for many applications. The wood substitute, however, will not take the place of plastic gears, and this need, at present, remains unfilled. Steel is a satisfactory substitute where noise is not of prime importance.

Castings in tachometers, formerly brass, are now iron. Since these are magnetic instruments, slightly different calibration was required.

Because of its light weight and quick response, aluminum has been used for speed cups of speedometers. Copper is now used for this purpose because there are no restrictions on copper used to carry electric current and operation of the part depends upon eddy currents.

Bezels which were brass, chromium plated, are now stamped out of steel and enameled, usually black, but a customer can specify colors to match his



*1—Now of wood fibre substitute, this part was made of phenolic resin plastic. 2—Copper takes the place of aluminum in speedometer speedcups, and steel substitutes for brass in jewel holder. 3—Steel shells are cadmium plated inside and oustide as alternate for brass in gasoline gage float. 4—Phosphor bronze substitutes for nickel fuel pump switch frame. 5—A newly designed tachometer has an iron casting in place of a brass casting. 6—Indicator pointers are stamped out of thin steel instead of aluminum. 7—Interchangeable parts for air pumps, that at left is zinc aluminum casting, that on right a steel substitute. 8—Bezels, formerly chromium plated brass, are now enameled stamped steel*

scheme for maximum sales appeal.

Gasoline gage floats have always been brass for two reasons — light weight and depth of draw involved. Floats are now steel shells, cadmium plated inside and out to avoid internal corrosion. To plate the inside, it is necessary to hang a separate anode in each piece.

Indicator pointers which were aluminum are now made of thin steel.

A newly developed Stewart-Warner unit was originally an aluminum casting. Case, frame, hubs and bosses were part of the original casting. Now an internal cast iron frame is housed in a stamped steel shell. Higher tooling cost has been slightly offset by reduced material cost.

Since phosphor bronze can be obtained for electrical conduction, this material is used for fuel pump switches as an alternate for nickel.

Because of the rusting of fine mesh steel, air filter screens were made of brass. Steel is now used, plated with cadmium that does not clog down to 80 mesh per sq. in.

In air pumps, a steel part made on a screw machine substitutes for a zinc-aluminum casting. Although thicker and heavier, it is interchangeable for fitting and performance.

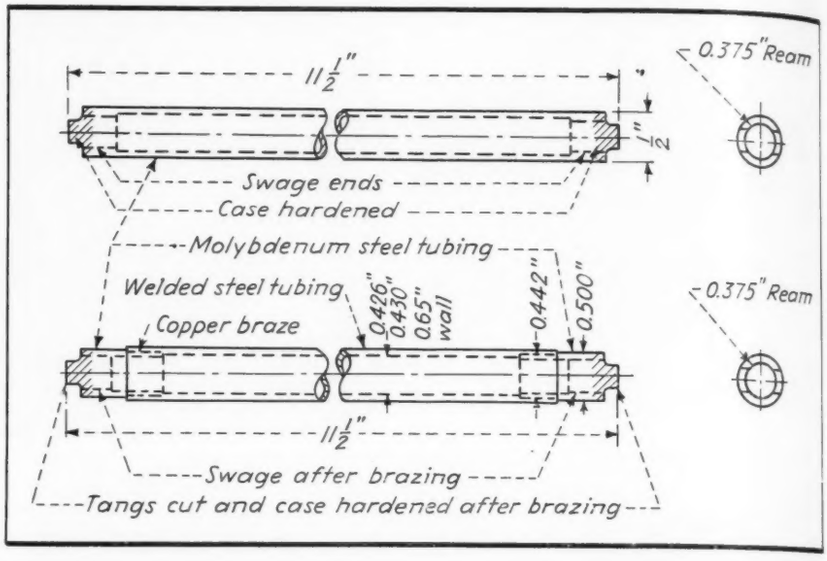
Hose ferrules, formerly brass, for crimping and spinning over rubber tubing, are now made of thin-wall steel. When possible, wood is substituted for aluminum handles.

A good, general purpose alternate material has been found in air-furnace iron. It has high tensile strength—higher than gray cast iron—allowing reduction of wall thickness to keep weight down. It has been used to substitute for aluminum and brass castings and forgings.

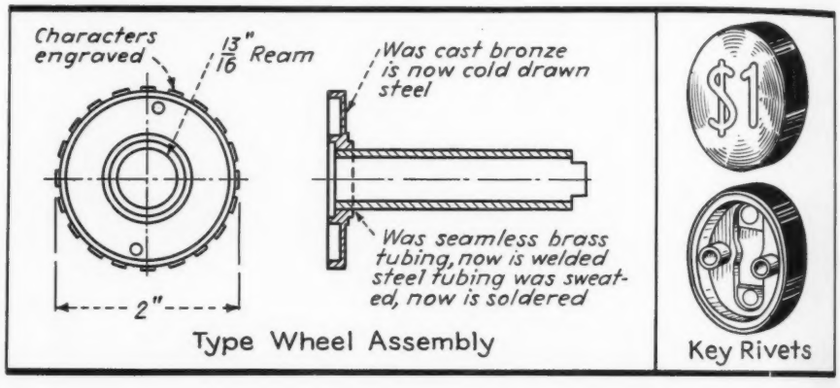
A new method of producing brass or bronze color on steel has been developed at Stewart-Warner. By controlling the baking temperature of clear enamel, a wide range of brown tones can be obtained. A low temperature gives steel so coated a nickel-plated appearance. Higher temperatures darken the color through a range of brownish tinges, with metal showing through, causing a deep bronze appearance.

# Cold Rolled Steel Replaces Bronze, Moly Steel

**Table drive gear tube** on commercial bank posting machines, shown at lower right as being tried out by National Cash Register Company, will make stock of ½-in. S.A.E. 4615 molybdenum steel tubing go nearly nine times as far as when using one-piece tubes of this material. The new three-part tube consists of a low carbon welded steel tube center section of slightly increased diameter copper brazed at above 2,000 deg. F. to moly steel ends. Ends are swaged and reamed to make bearing surfaces for shaft through tube. Tangs are heat-hardened after these operations. Of nearly 3,000 materials changes, most are substitutions of cold drawn and cold rolled steel parts for bronze or copper bearing materials which involve no design change.



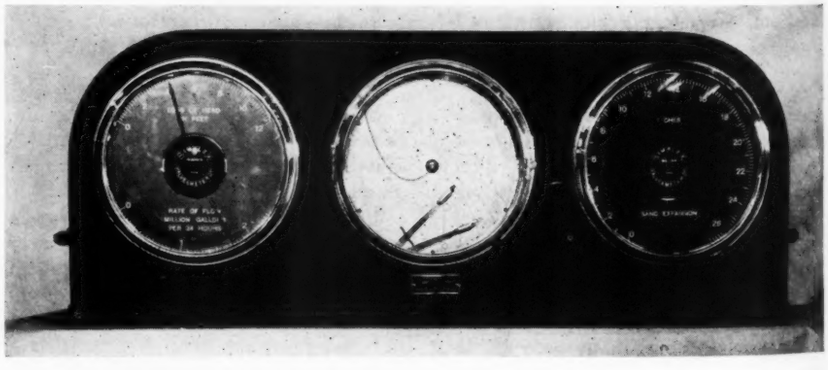

**Type-wheel** operating assemblies, such as that shown at right, formerly consisted of cast bronze type-wheel sweated to seamless brass tubing. Cold drawn steel type-wheels are now soldered to welded steel tubing. Tests indicated that the new assembly has four times the strength of the old. Figures on the rim are engraved as before. Tiny key tip rivets, shown at far right molded into plastic key tip, required 600 lb. of $\frac{3}{32}$-in. brass rod per month. High sulphur steel is used now.

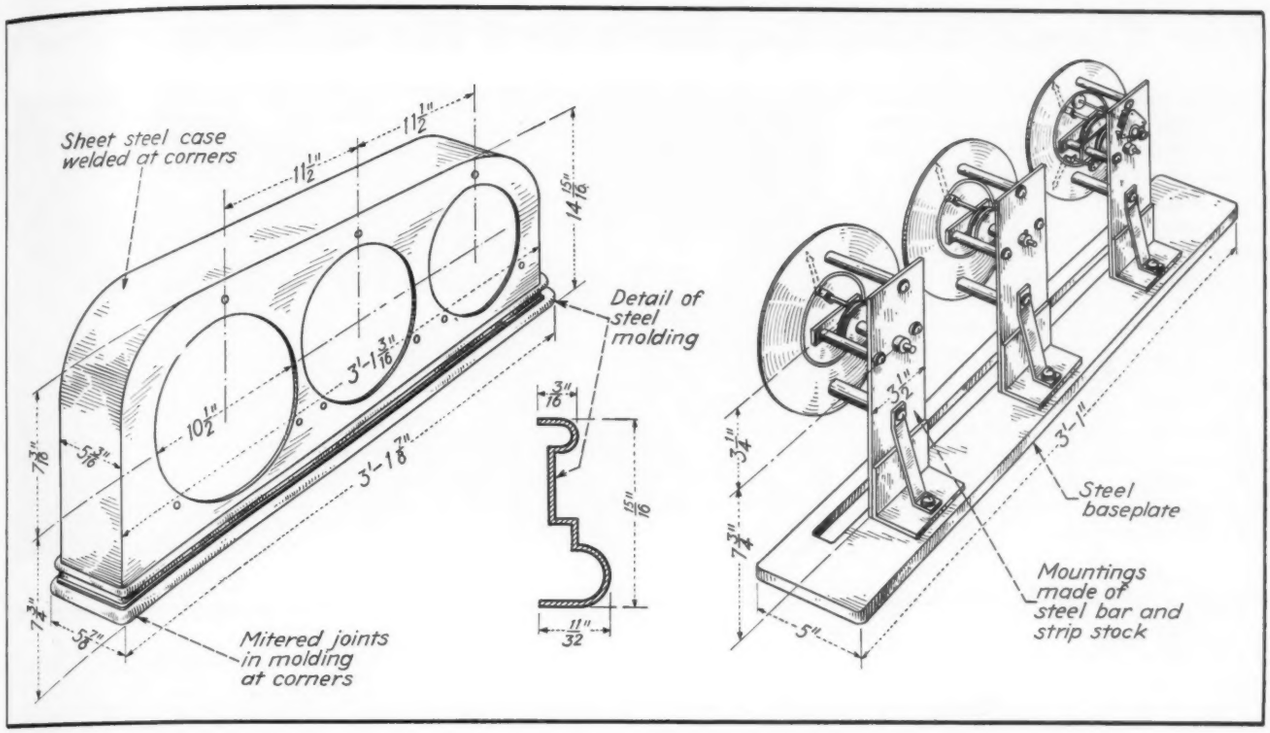

Characters engraved
13/16" Ream
Was cast bronze is now cold drawn steel
Was seamless brass tubing, now is welded steel tubing was sweated, now is soldered
2"
Type Wheel Assembly
$1
Key Rivets

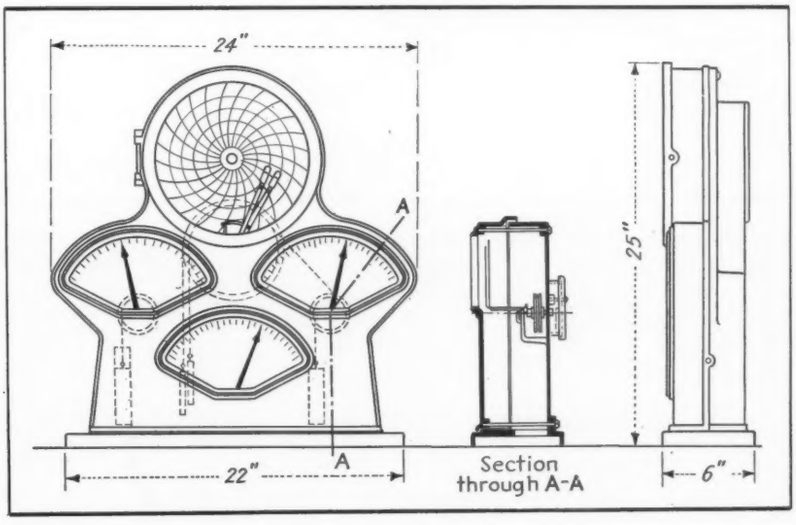
# Compact Gage Units in Steel Cases Save Aluminum

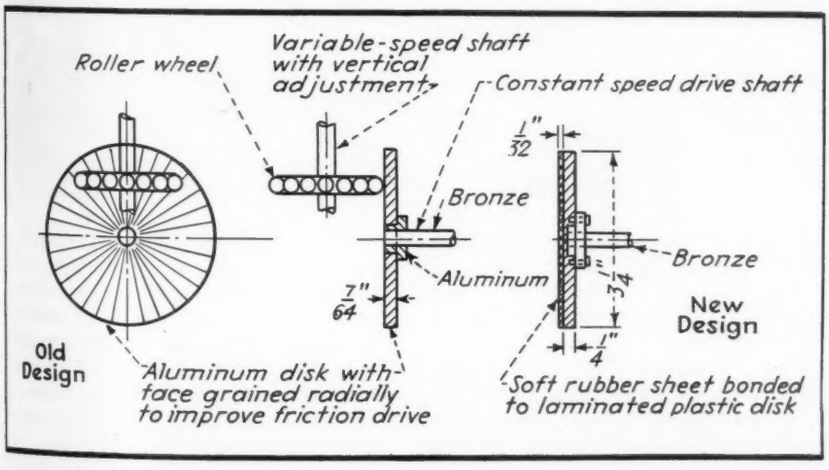
**Gages** for indicating and recording loss of head and rate of flow in water supply systems were formerly housed, by the Simplex Valve & Meter Company, in sand cast aluminum cases. The case consisted of two castings, one formed the front of the case, and the other formed the base and back panel of the case. To facilitate inspection of the interior mechanisms the front casting was fastened to the back casting with screws. Bracket arms cast integrally with the back of the case are machined to support the dial shaft elements and pivot bearings of the indicating mechanism.

As redesigned for fabrication in steel, in order to conserve aluminum, the gage case consists of a sheet metal cover and a steel plate for a base upon which to mount the gage mechanisms. The cover is held to angle clips on the base by small screws. The supports for the internal mechanisms are constructed of steel plate, strip and bar. The gage assemblies shown here are comparable in function. That shown in the center of next page consists of three indicating elements and one recording element, all contained in a single sand cast aluminum case. The assembly shown above and at the top of next page consists of one recording element, one single indicating element and one double indicating element which further conserves space. Through this method of redesign and use of steel, the amount of aluminum saved per instrument group is from 10 to 15 lb. on the average.




Sheet steel case welded at corners
Detail of steel molding
Mitered joints in molding at corners
Steel baseplate
Mountings made of steel bar and strip stock

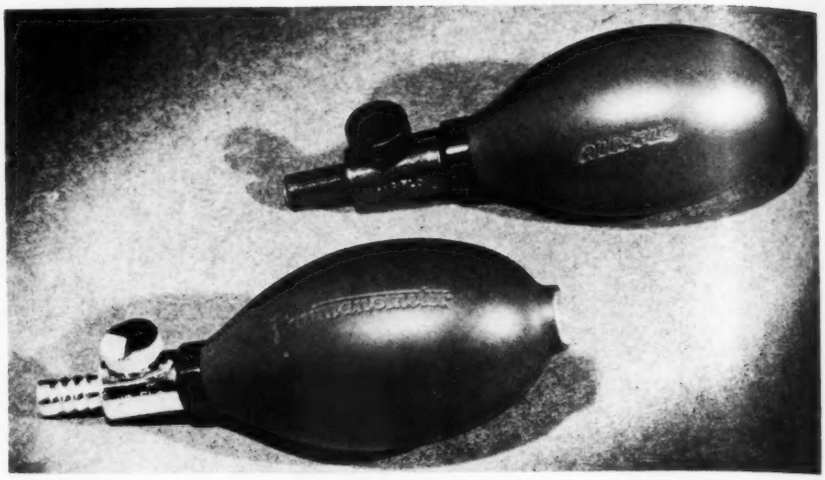


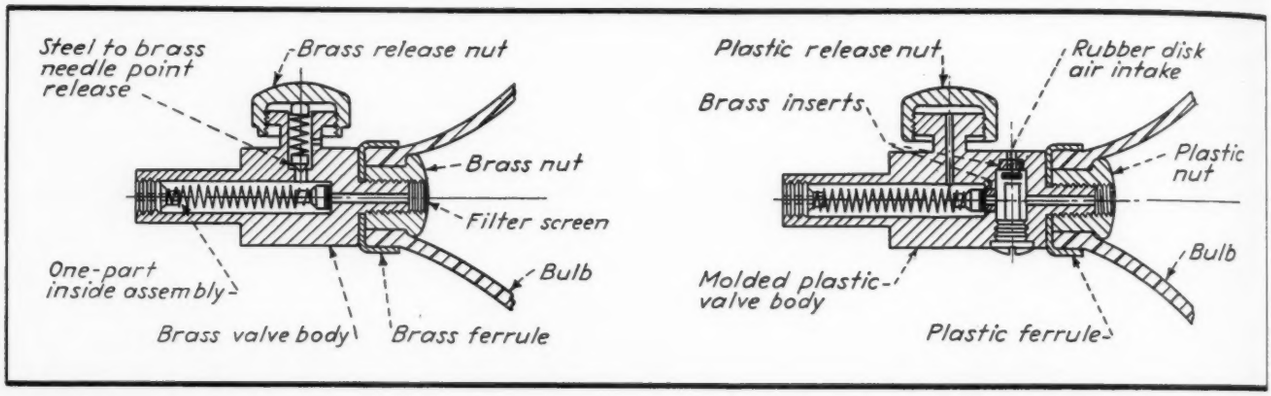




**Roller wheel** and disk drive in a recording instrument, made by the Simplex Valve and Meter Company, formerly used an aluminum disk with a pressed-in aluminum hub part, to drive by a friction wheel fixed on a shaft which is adjustable radially across the face of the disk to obtain variable speed. To improve frictional properties the face of the aluminum disk was grained with fine radial scratches. In order to conserve aluminum the disk is now made from a laminated paper base plastic to which a soft rubber sheet is bonded to provide a driving face. Shaft, $\frac{3}{16}$ in. dia. by 2 in. long, is made of bronze to resist corrosion.

# One Plastic Valve Replaces Two Metal Parts

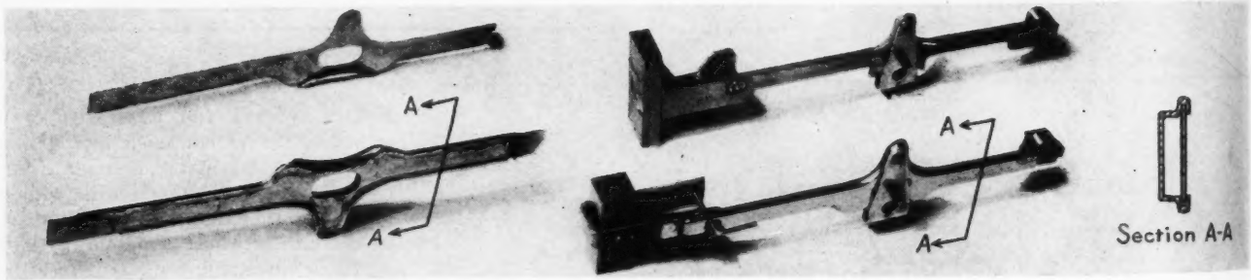
**Air-Flo control unit** of Baumanometer blood pressure apparatus now combines air intake valve, outlet valve and release valve in one molded plastic unit, eliminating valve in end of bulb and replacing chromium-plated brass screw-machine valve body of previous design. Weight of new design is reduced by 1 oz., important in doctor's portable unit weighing less than 30 oz. Bulb is anode dipped latex. Cellulose acetate-butyrate was selected for new valve because of its greater dimensional stability and moisture resistance. Both valve and bulb are distinctive green color. Odorless synthetic rubber will probably replace high-grade rubber for the bulb in the future.





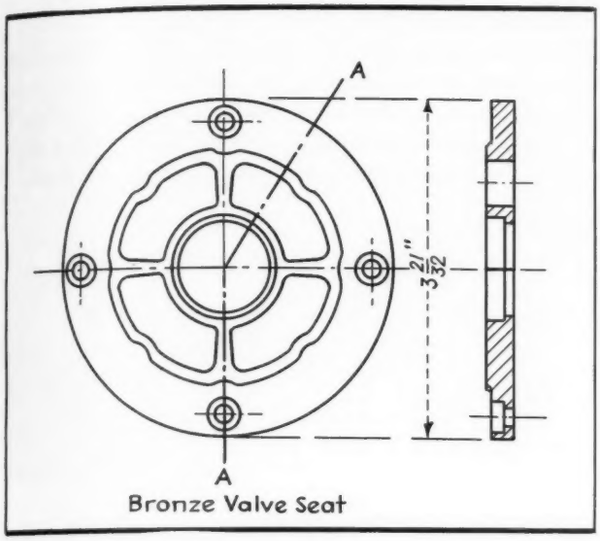

**Air intake of new control** unit is through simple rubber disk valve in molded part. Small size of intake hole, located just back of release nut, eliminates necessity for dust filter. Outlet valve assembly remains the same; both outlet and intake valve assemblies can easily be removed. In release valve, steel-to-brass needle valve is replaced by small drilled hole leading up under thumb nut. Screw threads have small groove for escape of air when nut is loosened. This design gives the doctor smoother control over escape of air to facilitate accurate manometer readings.

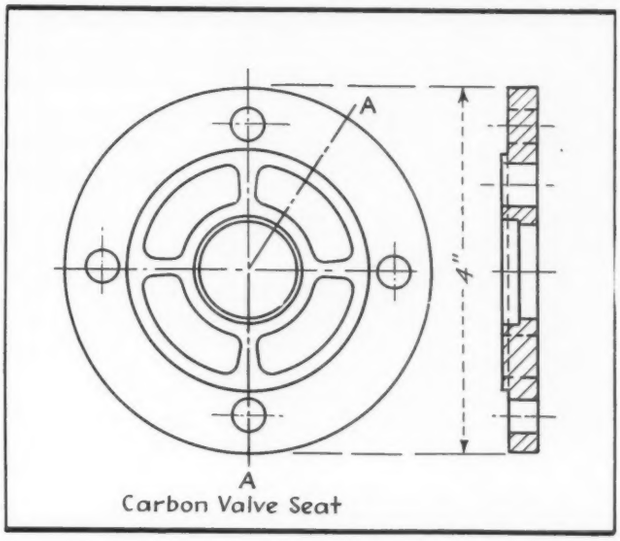
# Hollow Steel Arm as Rigid as Cast Magnesium




**Replacement** of priority materials is a problem for instrument makers as well as for manufacturers of large mass-production parts. Engineering ingenuity in designing small parts at least matches the best in redesign of large parts. Bailey Meter Company has recently redesigned and improved this hollow integrator roller arm only 1/16 in. thick in which sheet metal stampings replace a solid cast magnesium arm. The magnesium arm was heat-treated to extreme rigidity to maintain accurate centers, and to break under stress rather than deform. Required rigidity is obtained in the new arm with chrome plated steel stampings 0.008 in. thick soldered together with ordinary solder. Overall dimensions of the hollow portion of the arm are approximately 5½ x ⅜ x 1/16 in. Cadmium-plated steel replaces brass counterweight and is held by another stamping. The roller at opposite end is held by a stamped part of thumbnail size. Both are of same material as arm and are welded to it. Welded clips hold shafts in place.

# Carbon Valve Seats Found Better Than Bronze

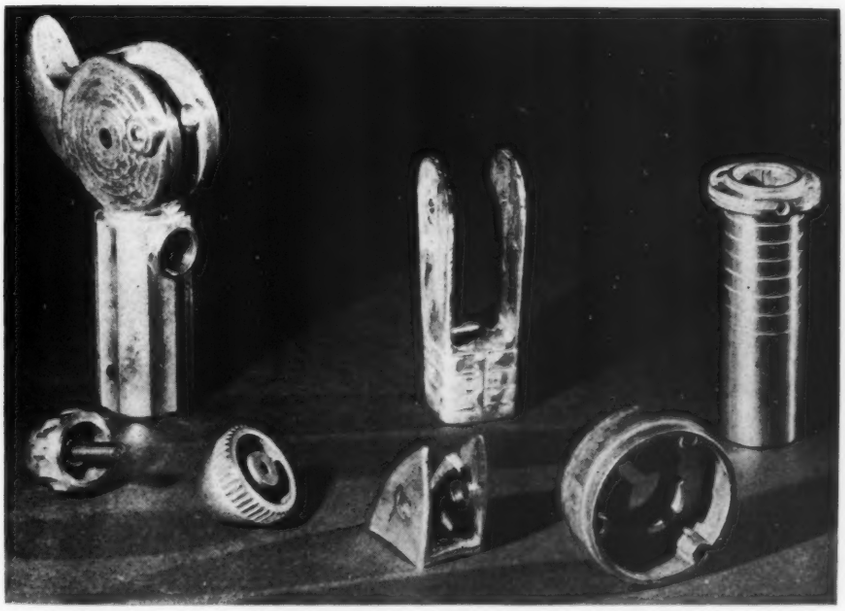



**Valve deck or seat** in Gilbert & Barker gasoline displacement meter has for many years been made of a cast bronze composition (tin 9.14%, lead 2.25%, copper 86.52%, nickel 0.09%, zinc 1.94%). When restrictions on bronze came into sight, research successfully developed a carbon seat (No. 1 Graphitar) that exceeds performance of bronze. Coefficient of friction and gum adhesion are less and the seat becomes better with age. The Z-metal valve rotating on the carbon laps and polishes the surface, creating a positive seal. Manufacturing cost is approximately the same, but a saving will be effected in less rejections and reduced field service. Bronze released to more important war uses is 0.8 lb. per pump. The change to graphite will be permanent, because laboratory and field experience has convinced Gilbert & Barker that graphite is superior to bronze in all ways for this part.

# Less Strategic Materials Used in Lamps

**Replacing spun aluminum** reflector hood, the new Theralux heat lamp bulb has self-contained reflector—a thin film of aluminum condensed on inside surface of specially shaped bulb. New hood is spun steel, bronze enameled inside and out. It serves only to protect the bulb and for appearance. New heat lamp has improved infra-red output and glows with dull red light instead of bright light of previous bulb. New adjustable bracket also uses less material.



**During period of zinc shortages** last year lead-antimony was substituted for zinc in many die-castings. Typical are sun lamp parts shown above. Lead-antimony is more ductile and not as strong as zinc alloy, so for many load-carrying parts it is necessary to add stiffening ribs and to strengthen sections when switching from zinc to lead die casting alloys. This substitution is only temporary, and zinc alloys will be used again as soon as possible.

# Miscellaneous Instruments and Devices

### 1. GLASS TUBING CONSERVES NICKEL-CHROMIUM

ENGINEERING STUDIES made for the purpose of conserving strategic materials, by the Brown Instrument Company, have resulted in the use of Vycor glass tubes to save nickel chromium alloy formerly used in tube form as a protecting sheath for thermocouples. Design *A* uses a nickel chromium alloy drawn tube. Design *B* uses a tube made of Vycor, a 96 percent high silica glass which is generally comparable with fused silica or fused quartz in being able to withstand high temperatures and extreme conditions of thermal shock.

PROPERTIES OF "VYCOR" GLASS

| | |
|---|---|
| CHEMICAL COMPOSITION | 96 percent $SiO_2$, balance chiefly $B_2O_3$ |
| PHYSICAL PROPERTIES | |
| Softening point | 1,510 deg. C. ± 30 deg. |
| Annealing point | 890 deg. C. ± 20 deg. |
| Strain point | 790 deg. C. ± 20 deg. |
| Density (Sp. G.) | 2.18 |
| Coefficient of linear expansion | 7.8 to $8 \times 10^{-7}$ |
| Max. temperature for use for limited periods, | 900 to 1,000 deg. C. |

### 2. PLASTICS RELEASE STAINLESS METALS

PRESSURE RUPTURE DISK and flanges of safety device manufactured by Black, Sivalls and Bryson, Inc., are made entirely of phenolic plastics, releasing stainless metals. Rupture disk is fabric-base laminated with phenolic varnish. Flanges of "insert" type are of cast phenolics, and are bolted to stainless steel nozzle of pressure vessel to be safeguarded. Cast resin was found to be easy to machine. Also plastic plates cost only one-sixth as much as stainless steel plates. Strength of plastics confines service of device to relatively low pressures of 150 lb. per sq. in. or less. This device was Modern Plastics Competition award winner.

### 3. THICK FELT DOES JOB OF SPONGE RUBBER

SPONGE RUBBER PAD was formerly used on A.C. Gilbert's Vitalator to transmit soft vibrations from unit to hand. In January this was changed to a resilient felt pad ½ in thick. Performance of the two materials are about equal; rubber was preferred because it does not show dirt so readily.

### 4. VALVE REDESIGN SAVES SCARCE MATERIALS

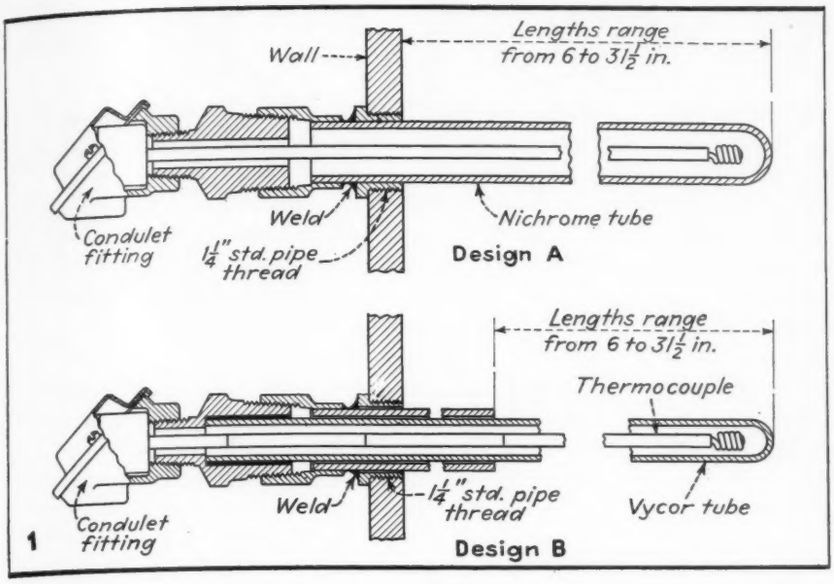
SEVERAL MATERIALS CHANGES were made in this automatic regulator and control valve for gas heating equipment made by The Bryant Heater Company. The throttling valve and shaft, formerly of solid brass, retains brass only in the valve which is pressed on a steel shaft and held by prick punching. The annular disk against which the diaphragm rests when incoming gas pressure forces it upward, was formerly of magnesium base alloy, as were the two cast rings holding the main valve seat ring. These parts have been changed—the disk to sheet steel and the rings to cast iron. Since steel is stiffer than Dowmetal the new disk is flat instead of being dished as shown. Its increased weight is compensated by substituting a lighter weight on the throttle valve shaft. Original plans to substitute paper base phenolic resin material for magnesium base alloy were dismissed when this material also threatened to become difficult to obtain. The main valve seat which was formerly die-cast aluminum is now of cast iron with no change in design.

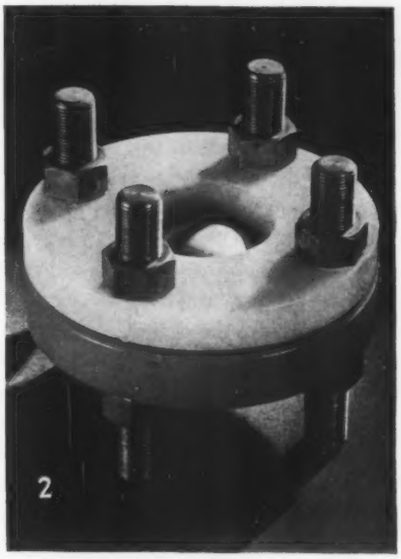
### 5. NO METAL IN NEW GAGE HOUSINGS

RECENT DESIGNS of Ashcroft Duragauge housings have eliminated nearly all metal and have achieved more efficient use of plastics. Designed several years ago to replace usual brass case, the original plastics case was of conventional shape. Recently redesigned, functional "turret" shape shown at right is several times stronger, uses only slightly more phenolic resin. Finish on new case is dull to avoid distracting reflections. Gage cover is now molded of acrylic resin, saving considerable amount of brass formerly used in rings which held glass in place. Another important change is the dial, previously made of aluminum, now of laminated plastic. Numerals are printed on impregnated cardboard, and layers of non-reflecting clear urea plastics are laminated under heat and pressure to both sides of dial.

### 6. METER SOCKET NOW MADE OF SHEET STEEL

HUNDREDS OF TONS OF ALUMINUM are released by forming meter sockets from sheet steel at the Meter Division of the Westinghouse Electric & Manufacturing Company. Although aluminum has certain advantages for outdoor locations, a satisfactory substitute was developed by drawing the sockets from sheet steel after which a water proof finish is applied.


Wall
Lengths range from 6 to 31½ in.
Weld
Nichrome tube
Condulet fitting
1¼" std. pipe thread
Design A
Lengths range from 6 to 31½ in.
Thermocouple
Weld
1¼" std. pipe thread
Vycor tube
Condulet fitting
Design B
1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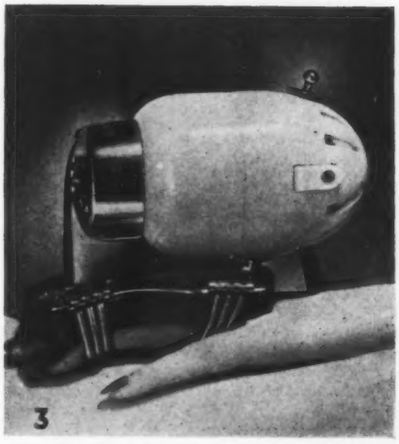
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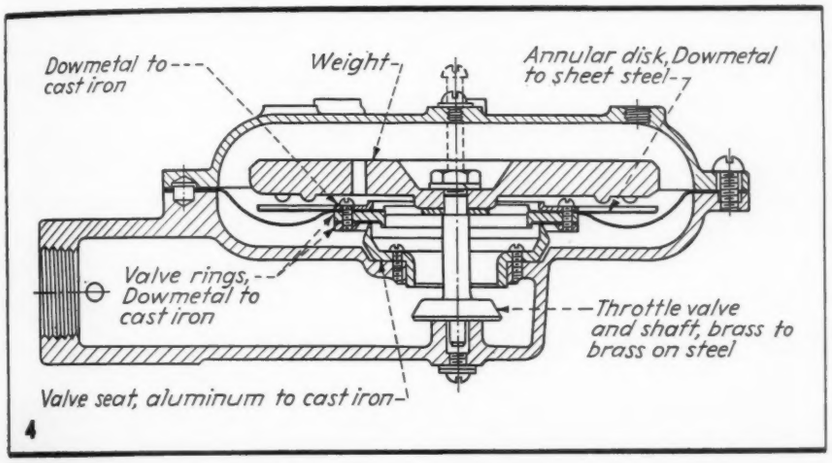
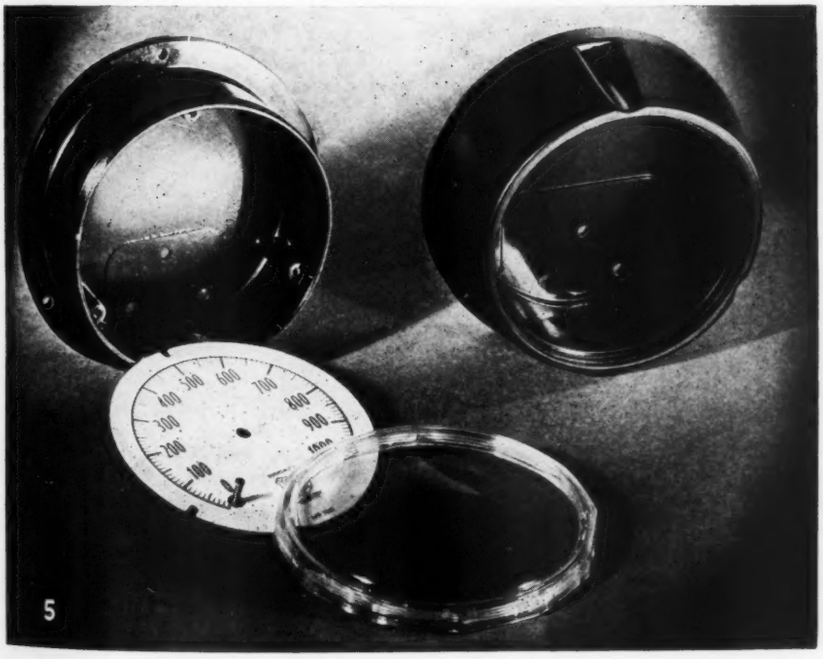

Dowmetal to cast iron
Weight
Annular disk, Dowmetal to sheet steel
Valve rings, Dowmetal to cast iron
Throttle valve and shaft, brass to brass on steel
Valve seat, aluminum to cast iron
4


5

6

# DESIGNING TO REDUCE SCRAP

THE AMOUNT OF MATERIAL USED is determined not by the weight of the finished part, but by the weight of the material out of which the part is made. Although by reclamation a relatively high percentage of the scrap can be reclaimed, this involves both an appreciable loss of metal plus the time, work and energy required to remelt and refine the scrap. Therefore the designer can contribute much to materials conservation by laying out his designs so that a minimum amount of scrap will be produced in the manufacturing operations. Also, in order to make more efficient the work of scrap reclamation, the designer will contribute much by specifying in many cases the purchase of finished parts of brass, bronze and special alloys. In this way, the machining scrap is all produced in the plant of the company that is producing the alloy. Because that plant is specializing in that class of alloys, it will be much more economical for them to reclaim the scrap than if the scrap were produced in the plant of the purchaser.

Thus, unless a plant has a large screw machine department producing nothing but brass parts, it will be more economical from the point of materials conservation for that plant to purchase finished brass screw machine parts rather than bar stock. As another example, insofar as the national problem of materials conservation is concerned, it may be far better to specify a die-casting if the percent of machine scrap were to run high.

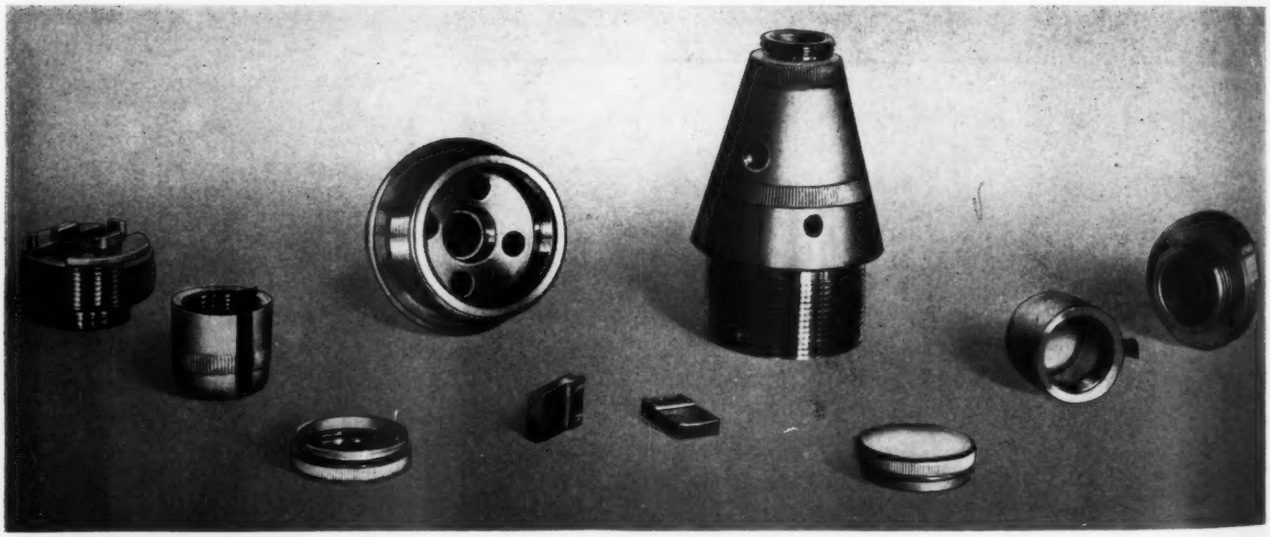
Similarly, it may be more economical to purchase steel stampings rather than using machined parts. This not only may save material but will also release machine tools for other jobs.

Of course the most effective method to minimize scrap is to use standard parts wherever possible and reduce the number of different sizes required to a minimum. Not only will this procedure often greatly reduce the amount of metal consumed but it may also avoid the necessity for making special die jigs or tools, production capacity for which is jammed.

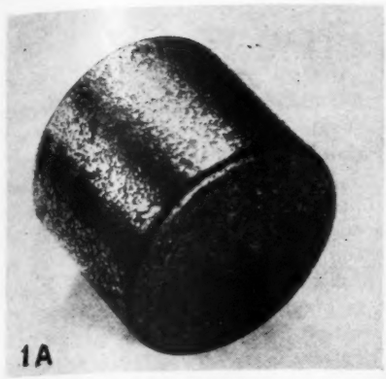
Another excellent example of how material can be utilized with a minimum of waste, in the design and construction of one type of sheet metal product, is described on pages 196 and 197 of this issue. In the fabrication of this instrument case the designer has used for the back panel a blank stamped from a one-piece flange ring stamping.

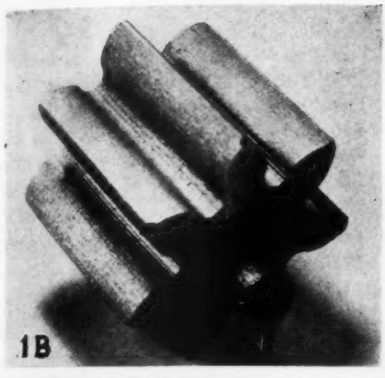
Underlying the design of the products shown here will be noticed a few general design principles, the application of which will reduce scrap.

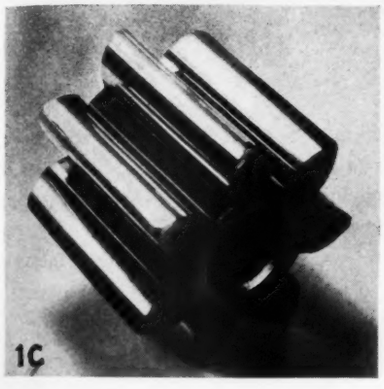
## Shell Fuse Parts Now Die-Cast

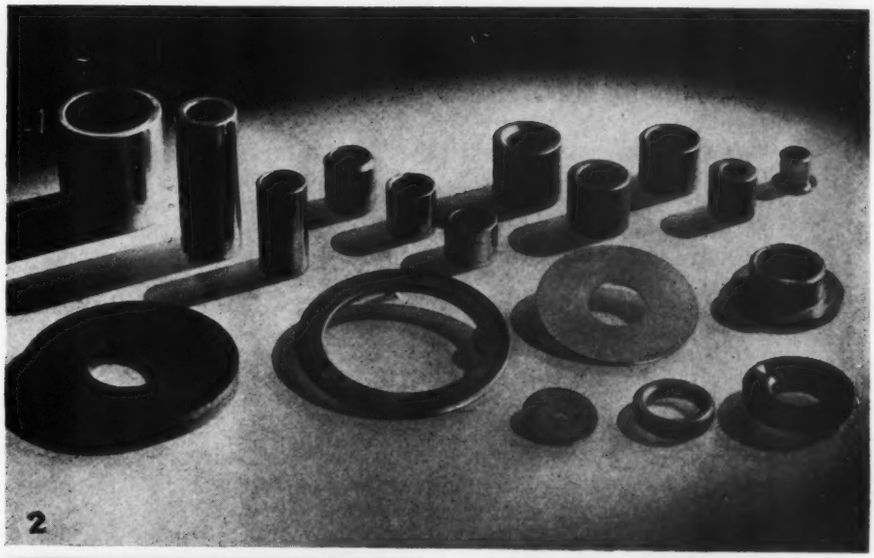


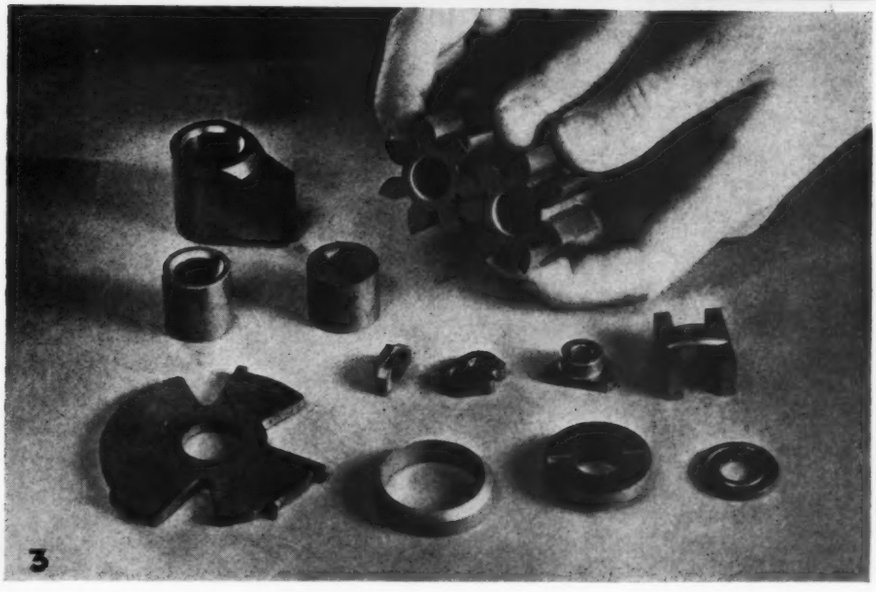
**Scrap metal** removed in finishing parts which have been die-cast to close tolerance is small; in cases where turnings can be immediately returned to the die-casting machine, scrap loss is nil. This was one important reason why zinc alloy die-castings have replaced brass in Canadian shell fuse parts, two views each shown above. These parts were formerly turned out on screw machines from bar stock. Metal removed in screw machines was considerable, and production time was long. Present die-cast parts require only finishing cuts, chasing, and drilling and tapping of some of the holes, taking only a fraction of previous production time. Scrap is immediately remelted and recast. Alloy is carefully checked against impurities. Die-castings are held at 200 deg. F. for 6 hr. after being removed from the machines to stabilize them. Close inspection guards against any porosity in the castings.




*1—The cast iron blank weighs 0.8 lb. and must be machined down to 0.28 lb. to make the gear in the center. The powdered iron gear weighs only 0.21 lb. and takes a high polish by burnishing. 2—To conserve copper and tin used in bronze bearings, these powdered iron bearings and washers, which can be oil impregnated, are finding wide use. 3—Gears, cams, bearings and other small parts can be made of powdered metals with a resultant saving in scrap and use of machine tools*

# Powder Metallurgy Saves Metal and Machines

POWDER METALLURGY involves the process of "briquetting" or molding powderd metals to a desired form under pressures of 30 to 60 tons per sq.in., and then heating the "briquette" to just under the melting temperature of the powders. This heating or sintering produces a part with characteristics which partake in proportion of all the qualities of the powdered metals mixed in that part. See PRODUCT ENGINEERING, April 1941.

Its advantages are that practically no further finishing is needed except where very close tolerances are required. Material scrap and wear on machine tools are both saved.

Powdered iron parts are made of a mixture of iron powder and graphite which gives a structure similar to high carbon steel and has a weight 70 to 95 percent of that of an equivalent cast iron part. Tensile strengths run up to 25,000 lb. per sq.in. Commercial tolerances average 0.3 percent of a given cross-sectional dimension and 1 percent of length. Closer tolerances can be obtained if necessary. The 5 to 30 percent of porosity may be impregnated with oil for lubricating purposes.

Similarly, copper or copper and tin powders may be used to produce excellent bearings which can carry their own oil or through which oil may be forced. The mixture of copper and tin powders produces a part with the characteristics of a true bronze bearing. To conserve tin, the Moraine Products Division of General Motors, who supplied the data and photographs, has introduced a 5 percent tin bronze instead of the 10 percent tin previously used.

# To Conserve Welding Electrodes

As is true for all metals, there is an urgent need to conserve welding electrodes. Design engineers can contribute much to such conservation by exercising care in the design of the joint to be welded and specifying the most efficient welding rod and welding conditions. The data and information given here were prepared by Clayton B. Herrick, welding engineer of The Lincoln Electric Company.

As shown on the opposite page, there is a type of joint best suited for each particular job. The simplest type of connection that will serve the purpose will not only avoid much waste of welding electrode but will also be quickest to make.

Although fit-up is not fully within the control of the engineering department, the designer can do a great deal toward assuring efficient fitting by specifying the proper joint preparation. If the gap in a fitted T-joint is $\frac{1}{16}$ in., the pounds of weld metal required will be almost 50 percent greater, while a gap of $\frac{1}{8}$ in. will require twice as much weld metal as needed for a properly fitted joint.

Following are some of the design and production precautions that should be taken in order to assure the most efficient use of electrode material.

1. Choose the correct type of electrode with respect to (a) physical properties required, (b) Type of joint (c) Position of welding (flat, vertical, overhead, or horizontal) (d) Condition of fit-up.

2. Specify the correct size of electrode. The largest diameter that can be used will be the most economical.

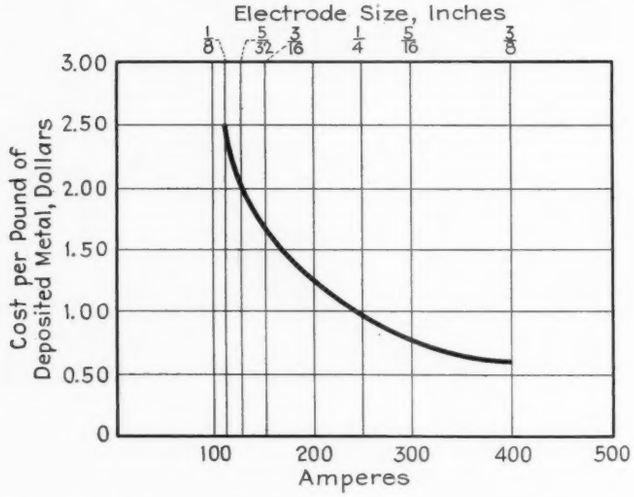
3. Specify long electrodes, 18 in. long for $\frac{1}{4}$ in. dia. and larger sizes. For maximum economy the electrodes should not be bent and the stub ends should be saved.

4. Specify fast flowing electrodes where possible and electrodes that produce a minimum of splatter and slag.

5. Specify proper voltage and current settings. All electrodes are designed to operate at an optimum voltage and within a specified current range. If current is too high or too low, excessive splatter loss or inferior welds will result.

6. Specify one bead of weld metal if it will meet design requirements. This same rule applies also to applications where two beads will suffice. Obviously the use of more beads than is required for service is a waste of electrode. Wherever possible use electrodes which produce flat beads so as not to deposit more metal than is required.

## ELECTRODE SIZE VERSUS WEIGHT AND COST OF JOINT




Electrode Size: Effect of electrode size on economy is shown in the chart at left and table below. Note how the cost of welding goes down as electrode size goes up. Note, also, electrode consumption rate, pounds of electrode deposited per hour, number of stub ends (indicated by interruptions per pound consumed), and cost of interruptions to change electrodes.

EFFECT OF CHANGING ELECTRODE SIZE

| Electrode Size | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
|---|---|---|---|---|---|---|
| Amperes | 110 | 130 | 150 | 250 | 325 | 425 |
| Arc Volts | 24 | 25 | 26 | 30 | 34 | 38 |
| K.W. at Arc | 2.64 | 3.25 | 3.9 | 7.5 | 11.1 | 16.1 |
| Consumption Rate, Lbs. Per Hr | 2.6 | 3.3 | 3.95 | 7.5 | 10.7 | 16.2 |
| Deposit, Lb. Per Hr. (50% Operating Factor) | 0.87 | 1.1 | 1.32 | 2.5 | 3.57 | 5.4 |
| Efficiency of Set (%) | 47 | 50 | 51 | 55 | 59 | 59 |
| Kilowatt Input | 5.6 | 6.5 | 7.65 | 13.65 | 18.8 | 27.3 |
| Interruptions Per Lb. Consumed | 18 | 12 | 8 | 5 | 3 | 2 |

COST PER POUND DEPOSITED

| | | | | | | |
|---|---|---|---|---|---|---|
| Labor | $1.150 | $0.909 | $0.758 | $0.400 | $0.280 | $0.185 |
| Overhead | 1.150 | .909 | .758 | .400 | .280 | .185 |
| Power | .064 | .059 | .058 | .055 | .053 | .051 |
| Electrode | .150 | .135 | .127 | .127 | .127 | .127 |
| Cost of Interruption (Including Overhead) | .050 | .033 | .022 | .014 | .008 | .005 |
| | $2.564 | $2.045 | $1.723 | $0.996 | $0.748 | $0.553 |

# COMPARISON OF WELDED JOINTS

## BUTT JOINTS

1—Plain Butt Joint. Largely used on plates up to ⅜ in. thick with metal electrode, ¾ in. with carbon electrode. Suitable for all usual load conditions.

2—Single V Butt Joint. Used largely for ⅜ in. plate or thicker. Costs more than and more electrode used than in (1). Used generally on plates thicker than in (1). Meets all general or usual load conditions.

3—Double V Butt Joint. Less weld metal used than in (2), cost of machining is more. Used largely for ½ in. and heavier, and for all usual loads. Joint welded from both sides.

4—Single U Butt Joint. Generally used for best quality work on plates ½ in. and over. Costs more to machine than single V but requires less electrode. Is welded from one side, except a single bead which is put in last on opposite side. Meets all usual load conditions.

5—Double U Butt Joint. Used where welds can be made from both sides—in plate sizes usually heavier than in (4) and where the saving in electrode used justifies the greater machining cost.

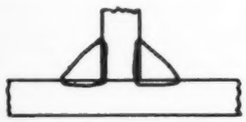
## CORNER JOINTS

6—Flush Corner Joint. Generally used for 12 gage and lighter. May be used for heavier plates but not for severe loads.

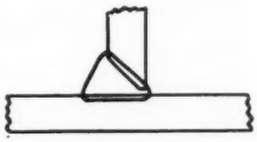
7—Half Open Corner Joint. Generally used for 12 gage or heavier where welded from one side only. "Shouldering" effect reduces probability of burning-through and makes for easy welding. May be used for ordinary loads, but with caution for fatigue or impact loads.

8—Full Open Corner Joint. Used for all plate thicknesses for severe load conditions and maximum strength.

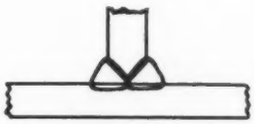
## TEE JOINTS



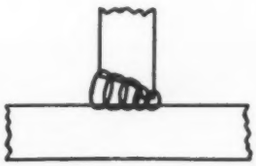
9—Plain Fillet Welded Tee Joint. Used without machining for all ordinary plate sizes. Most satisfactory when welds are in longitudinal shear. For welds heavily loaded transversely by fatigue or severe impact, use with caution.



10—Single V Tee Joint. For plates ½ in. or lighter welded from one side and more severely loaded than in (6). Costs more for joint preparation but uses less electrode than (6).

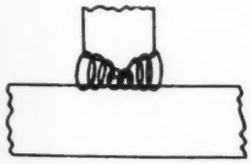


11—Double V Tee Joint. Used for heavy plates welded from both sides. Uses less electrode than (6). May be used for severe longitudinal or transverse loads of all kinds.



12—Single U Tee Joint. For plates generally 1 in. and heavier. Welded from one side only. Advisable to put in a final finish bead on side away from U. Machining costs more but takes less electrode than single V. For same load conditions as given under (7).

## LAP JOINTS



13—Double U Tee Joint. For plates generally 1½ in. and heavier which can be welded from both sides. More expensive preparation but uses less electrode than (8). For all load conditions, even severe.

14—Single Bead Lap Joint. May be used for all sizes of plates where joints are not subject to excessive fatigue or high impact loads.

15—Double Bead Lap Joint. Better than (14). May be used for load conditions too severe for a single bead lap joint. Beads should be full size. Butt joints (1-5) are the best for severe service but are more expensive.

## EDGE JOINT

16—Edge Joint. Generally used for ¼ in. or thinner. Not recommended for heavier work. For loads which are not severe.

# Material Conservation Through Lindsay Structure

LIGHT-WEIGHT, HIGH-STRENGTH inclosures are achieved through the use of Lindsay structures. Additional advantages are ease and rapidity of assembly which requires only a 4-in. socket wrench. Skilled workers are not required. A great variety of sizes and shapes of Lindsay elements available makes possible a great variety of shapes and sizes of inclosures.

The high strength-weight ratio of Lindsay structures is obtained by putting light sheet steel panels under tension. The panel sheet is usually 26-gage, hot-rolled annealed steel, with edges formed as shown at *A* in Fig. 1. Two such sheets are held together by a framing composed of a male or "tensioner" member (*B*), and a female or channel frame member (*C*). With the sheets engaged with the channel frame members, tensioners are tightened by the socket screws.

High resistance to tension and twisting forces have made Lindsay structures widely applicable for truck and trailer bodies. Other applications include radio housings, power and light equipment inclosures, dryers, machinery housings and casings, and storage or shipping containers. It is claimed that this type

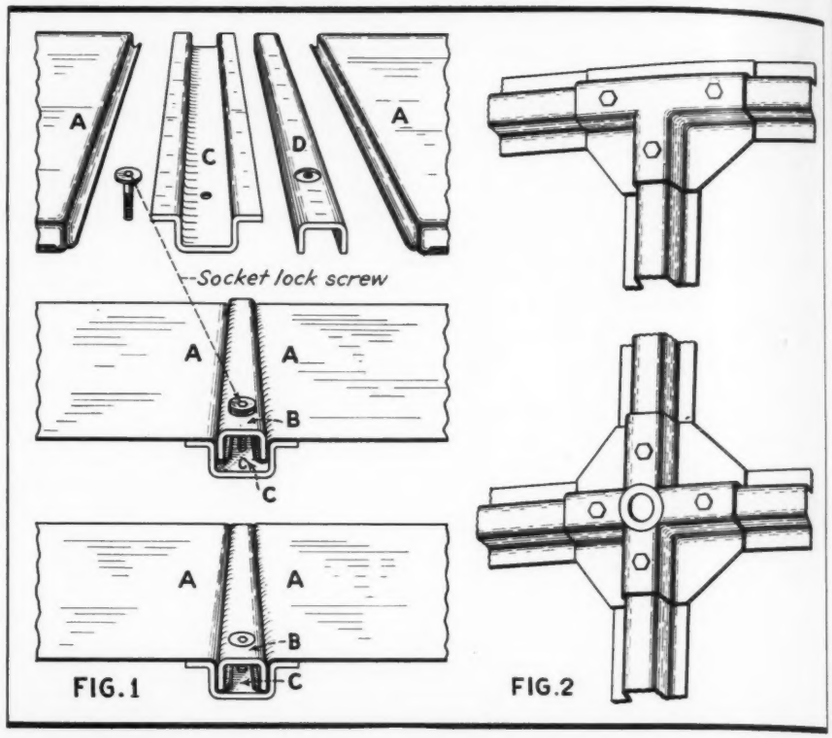
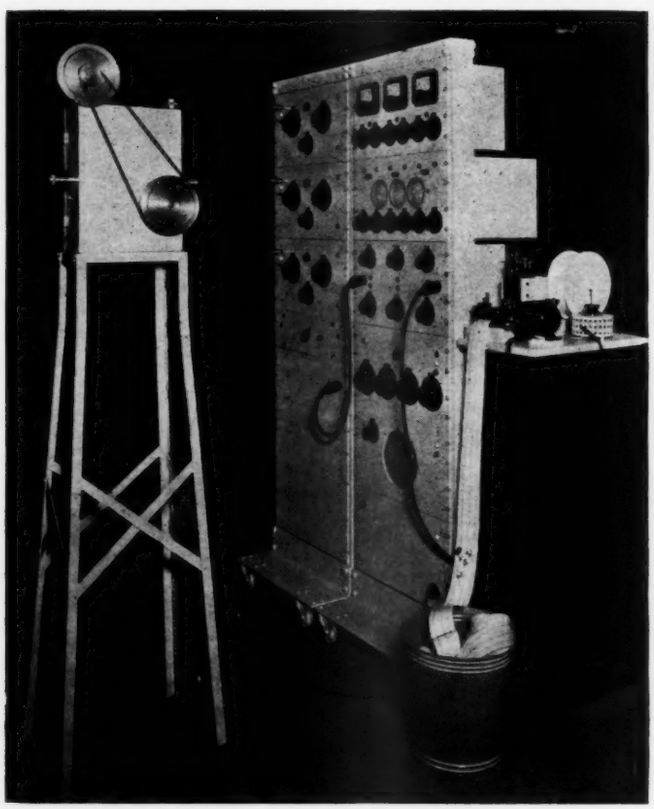



*Fig. 1—Basic elements of Lindsay structure, showing the progressive steps in putting the sheets under tension. Fig. 2—Connecting frame members of Lindsay structure*



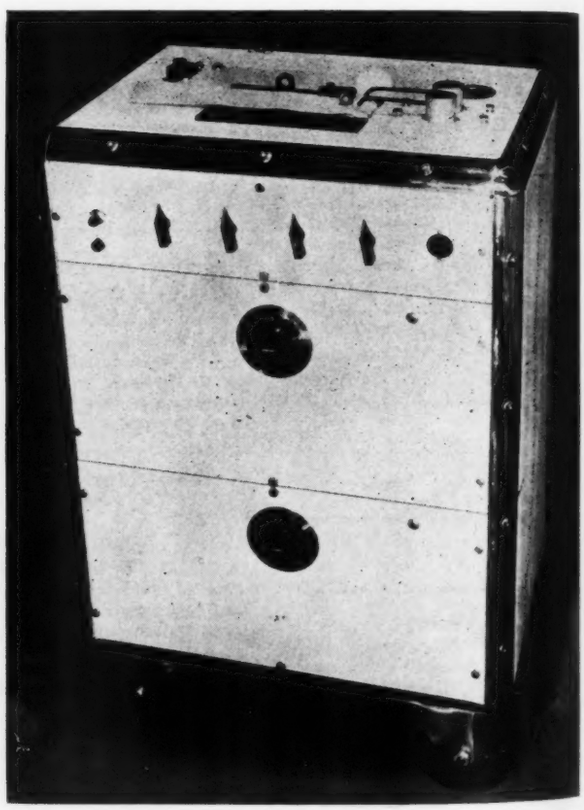


*Fig. 3—Complicated in design and extremely heavy, the older model of this electronic instrument for measuring nerve impulses, shown to the left, designed and built by the Electro-Medical Laboratory, could be moved from one location to another only with great difficulty. Housed in Lindsay structure, the machine is now a compact unit weighing only about 200 lb. as compared to 800 lb.*

of structure is sometimes not only stronger but also lighter than an equivalent unit made of aluminum.

In the Garceau electroencephalograph, Fig. 3, the engineers of the Electro-Medical Laboratories, Inc. redesigned the equipment so as to house all the units in a single Lindsay inclosure. This transformed a heavy, bulky apparatus usable only in specialized laboratories into a thoroughly practical piece of medical equipment that is portable. Portability is an important factor. The instrument is of great diagnostic value in neurology, for the detection of epileptic tendencies in men selected for aviation training, and in the prompt diagnosis of brain injuries from head wounds.

The earlier apparatus, left Fig. 3, was mounted in a pair of standard relay racks of conventional design, made of heavy panel members. Panels, to support the great weight of batteries, heavy transformers, and other units, were of 3/16-in. steel. Weighing in the neighborhood of 800 lb., the equipment could be moved only with difficulty. Portability of the instrument was, in any case, rather impractical because it required that the patient be placed in an electrostatically shielded room, which was constructed for every installation of equipment.

Built as a single unit, as shown to the right, in Fig. 3, the new apparatus weighs around 200 lb. and can be moved easily on 6-in. shock absorbing wheels An interference eliminator disposes of the need of a shielding cage so that the apparatus no longer requires an electrostatically shielded room.

The new apparatus is operated by plugging in on 115-volt, 60-cycle power. This eliminates maintenance costs of batteries formerly used. Simplifications of operating procedure is shown by the reduction in the number of controls.

A further advantage in this type of installation is that the mechanism is easily accessible for servicing since the Lindsay structure panel can be removed readily.

### MICA-ALUMINUM FINISHES

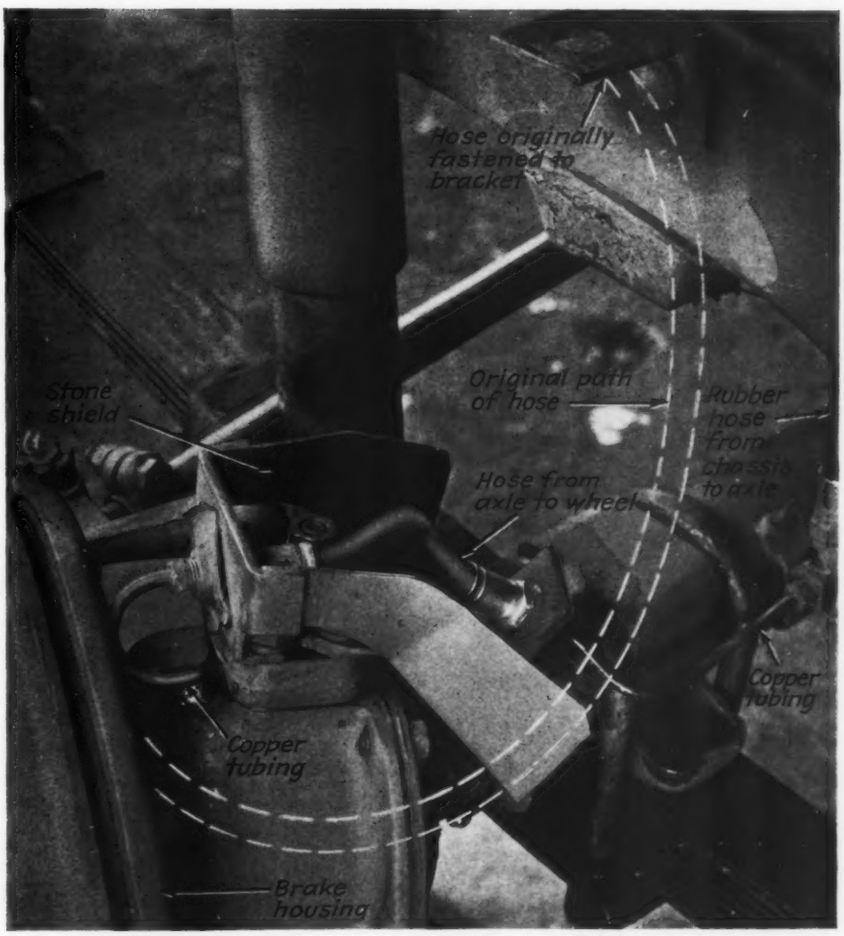
WHEN IT IS ESSENTIAL to use some aluminum powder to produce an aluminum-appearing finish, a saving can be effected by adding mica or talc to the aluminum powder. Three parts by weight of mica or talc and one part by weight of aluminum powder may be stirred into a mixing varnish to produce a finish with the characteristic aluminum appearance. This is the proportion of 2 lb. of the total pigment (including the tale and aluminum powder) to 1 gal. of the mixing varnish. If the fine lining grade of aluminum powder is used, as little as ½ lb. of it and ½ lb. of mica may be mixed with 1 gal.

# Automotive Design Saves Rubber in Three Places

THE WILLYS-OVERLAND COMPANY had to eliminate rubber almost entirely from all their automotive designs, two of which are shown here. In the design of the brake fluid lines over a foot of rubber hose was used to allow movement of the wheel with respect to the chassis. Two such sections were required for the front wheels. By redesigning, more than a foot of rubber hose has been saved on each unit.

The exhaust pipe and muffler of the customary automotive design are fastened to the frame by rubber mountings to absorb engine movement and vibration. To avoid the use of rubber, Willys-Overland used the method illustrated to absorb vibration.

Willys-Overland's investigation of substitutes for airfoam sponge rubber as used in automotive seats had interesting results. One set of sponge rubber cushions normally weighs 9.70 lbs. out of which 8.73 lb. are pure latex. One well-known possible substitute is stuffed curled hair as used in sofas. The set of seat pads made of stuffed curled hair would weigh 6.25 lb. and contain no rubber at all. Under steady use, it will pack down rather solidly after awhile. A second possibility is rubberized curled hair. This substitute contains 40 percent water dispersion reclaimed rubber (sprayed on the hair) and 60 percent curled pig and cattle hair; no crude rubber is used. These cushions would weigh 4.68 lb. and the weight of the reclaimed rubber would be 1.872 lb. No



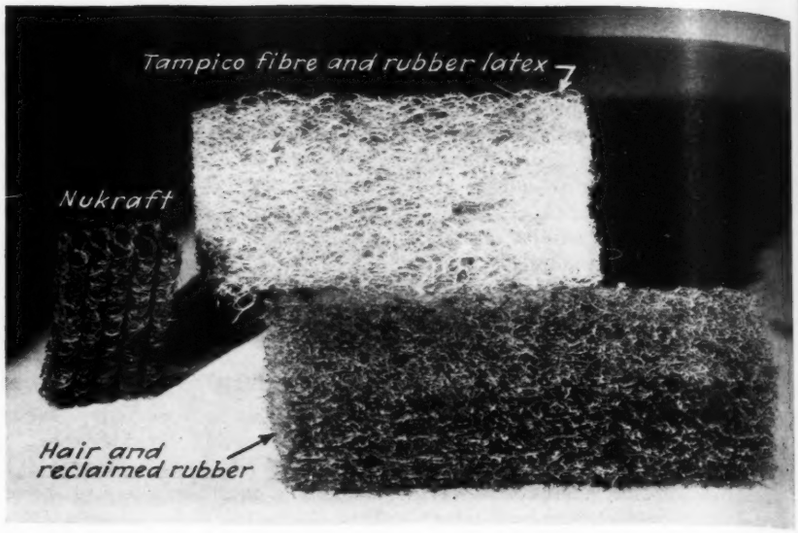

*Redesign of brake fluid flow lines saves rubber hose*

latex is required. This product has already seen varied use during the last half a dozen years.

A third sample is a rubberized Tampico fibre made of 2/3 fibre and 1/3 latex rubber which is sprayed on and cured. Cushions of this material would weigh 5.18 lb. of which the latex would be 1.73 lb. This product has been available for about two years.

One of the latest rubber substitutes is a material called Nukraft, made of hair and latex. Its springness and lightness depends a good deal on its form.

The densities of these products can be varied. The rubberized curled hair generally runs about 40 to 50 oz. per cu. ft. The rubberized Tampico fibre generally weighs from 35 to 45 oz. per cu. ft. All these types maintain their shapes and resiliency fairly well over considerable periods of use.




*These interesting substitutes for sponge rubber are available*

# Control Circuit Redesigned to Save Parts

TANDEM PACKAGING MACHINE in order to register wrapper trademarks before bottom edges of packages were sealed, formerly used an electronic circuit that consisted of two photo tubes, two light sources and two amplifier control circuits as shown in Fig. 3. During a primary feed operation, in the cycle of the machine, two lengths of preprinted wrapper material are drawn off the material rolls into an approximately correct position for sealing. This is followed by an electronically controlled solenoid operated secondary feed motion that accurately registers the trade mark or printed design in relation to the bottom edge of the package.

After the primary feed is completed, the cam switch *S* is closed, so that the circuits containing the solenoids can be opened or closed by means of relay controlled switches (not shown) connected across terminals 21 and 22. The relays for controlling the switches are in a thyratron tube circuit. When rays from light source pass through transparent areas of wrapping material to the photo tube, a small electric current is generated in the photo tube circuit, which in turn is amplified so that the relay controlled switch across terminals 21 and 22 is energized to bring solenoids into operation to perform the secondary feed motion until the light rays are intercepted by opaque printing on wrapper, thus rendering photo tube and its circuit inactive.

The control circuit for the tandem machine, as redesigned by the Stokes & Smith Company, shown in Fig. 4, saves one photo control-amplifier unit. The circuit shown in Fig. 4, however, has a cam operated double pole double throw switch that is not used in the circuit shown in Fig. 3. In Fig. 2 is shown the cam that operates the double pole double throw switch, the cam is timed at half the machine cycle, so that for one machine cycle the switch is closed to permit only the left hand light source and solenoid to operate and register the left hand wrapper.

In the following machine cycle, the switch is closed on the opposite side so that only the right hand light source and solenoid operates to register the right hand wrapper; and so on alternately thus accurately registering every other package on each side of the machine. Since the printed designs on the wrapper follow each other at uniform intervals there is not much variation in registered and unregistered packages.

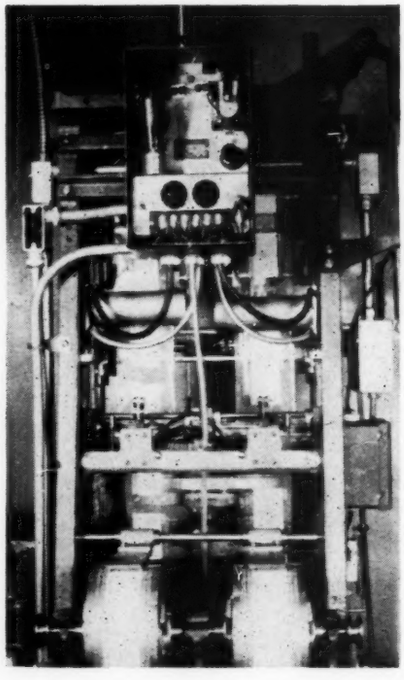


*Fig. 1—Rear view of tandem packaging machine with one photo control-amplifier*

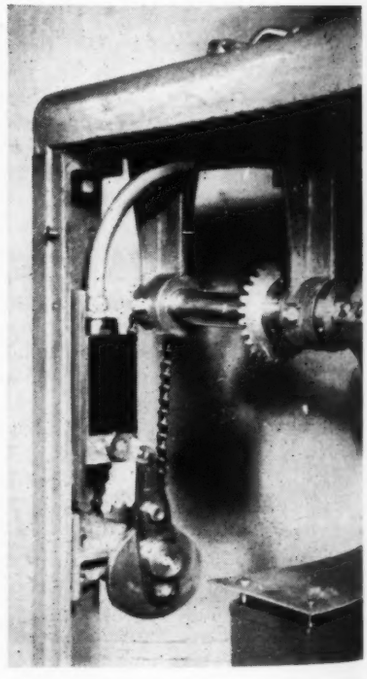


*Fig. 2—Double pole double throw switch is operated by cam on chain driven shaft*

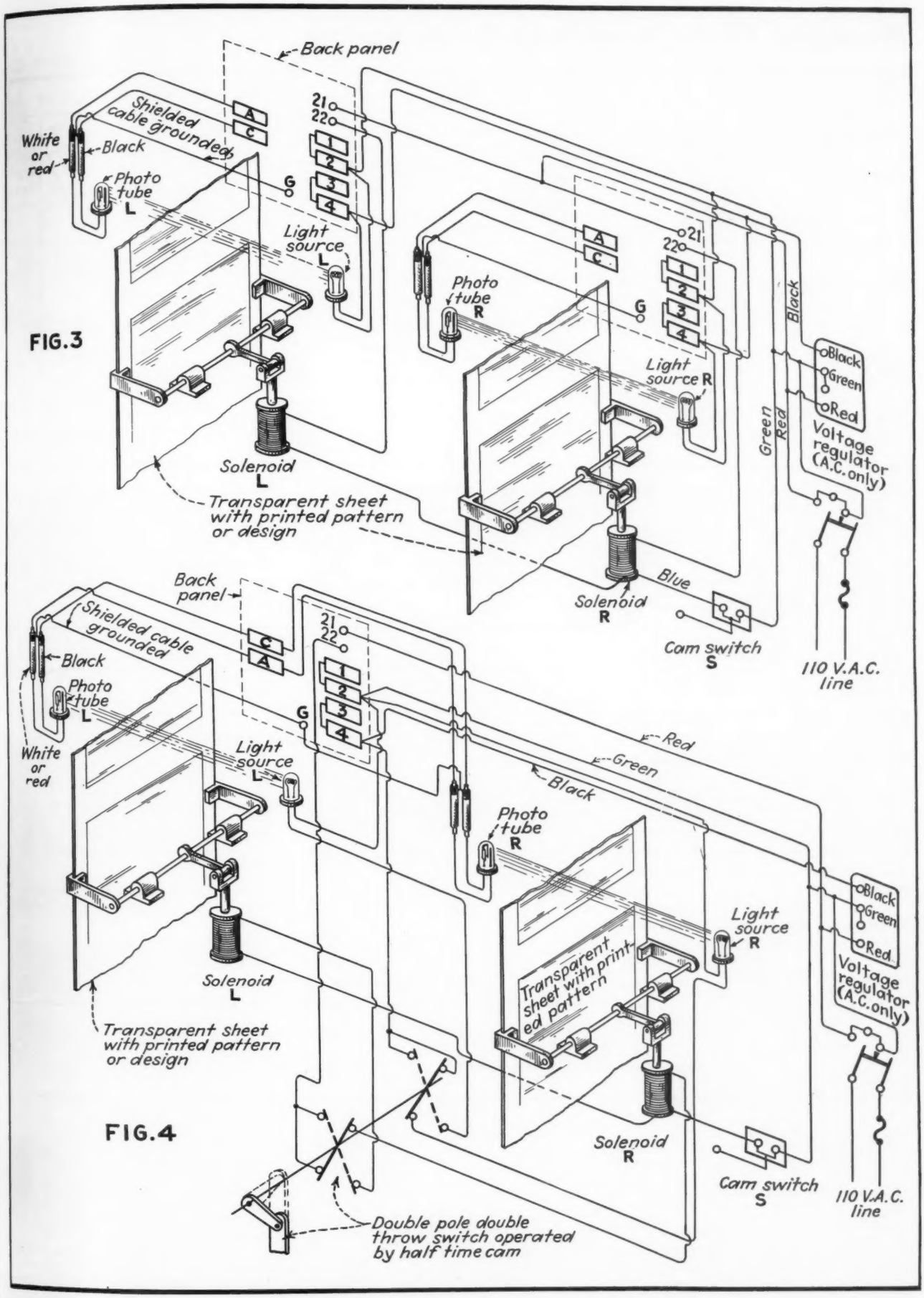
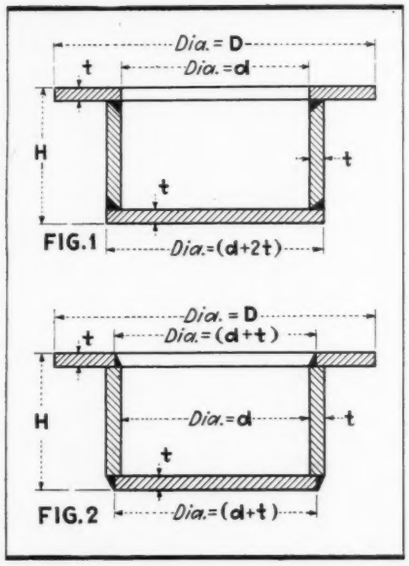

Back panel
Shielded cable grounded
White or red
Black
Photo tube L
Light source L
Solenoid L
Transparent sheet with printed pattern or design
Photo tube R
Light source R
Solenoid R
Blue
Cam switch S
Black
Green
Red
Voltage regulator (A.C. only)
110 V.A.C. line
21
22
A
C
G
1
2
3
4

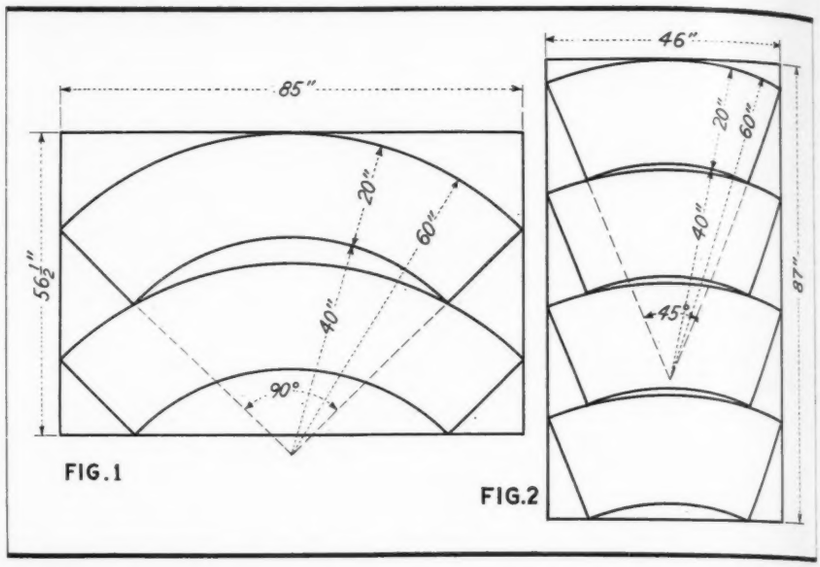
FIG.3


Back panel
Shielded cable grounded
Black
Photo tube L
White or red
Light source L
Solenoid L
Transparent sheet with printed pattern or design
Red
Green
Black
Photo tube R
Light source R
Transparent sheet with print ed pattern
Solenoid R
Cam switch S
Double pole double throw switch operated by half time cam
Black
Green
Red
Voltage regulator (A.C. only)
110 V.A.C. line
21
22
C
A
G
1
2
3
4

FIG.4

# Designs That Result in Less Scrap

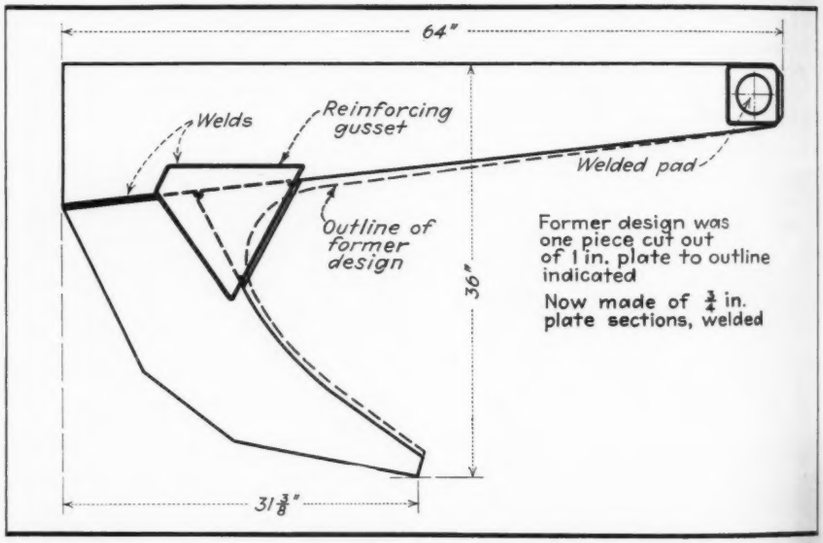



**Welded gear case** was first designed as shown in Fig. 1. The circular blank cut out of the flange ring and the material cut away from a plate to make the bottom for the case were scrap, since the bottom plate is larger than blank cut from flange ring plate. Engineers of the Whiting Corporation changed the design to that shown in Fig. 2. The disk cut out in making ring is made slightly larger and is used for the bottom of the gear case. Thus almost one half of the material is saved.

**A road machinery manufacturer** was cutting the piece at right from 1 in. thick steel plate. Considerable scrap resulted. In the redesign of the part, also shown, the part was cut out of two comparatively straight sections only ¾ in. thick, and gusset plates were welded on at the corner to give the needed strength at that point where stresses were highest. Only about one half the amount of material was required, the new design of hook-shaped part was lighter, stressed more uniformly, and cost was less.

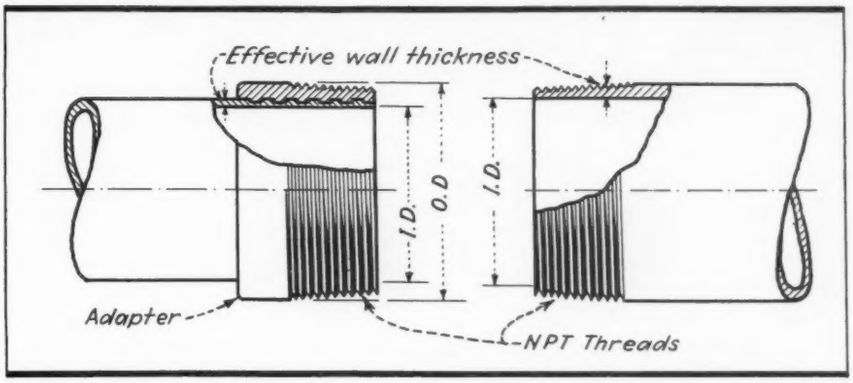
**Instead of cutting** a complete circular flange out of a flate plate, much material will be saved by cutting the flange in sections and welding the sections together to form the ring flange. The greater the number of sections, the less will be the scrap but the greater will be the welding required. Thus by making the above flange in 8 pieces instead of 4 pieces, only about one-half the amount of scrap is produced. Also, narrower plates can be used.




## Dimensions of Pipes and Tubes for Wallace Joints

| Nominal Size T=Tubing P=Pipe | ½ | | ¾ | | 1 | | 1¼ | | 1½ | | 2 | | 2½ | | 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | P | T | P | T | P | T | P | T | P | T | P | T | P | T | P |
| Outside Dia. | ½ | 0.840 | ¾ | 1.050 | 1 | 1.315 | 1¼ | 1.660 | 1½ | 1.900 | 2 | 2.375 | 2½ | 2.875 | 3 | 3.500 |
| Wall Thickness | 18 ga. | 0.109 | 18 ga. | 0.113 | 18 ga. | 0.113 | 18 ga. | 0.140 | 18 ga. | 0.145 | 16 ga. | 0.154 | 16 ga. | 0.203 | 16 ga. | 0.216 |
| Inside Dia. | 0.402 | 0.622 | 0.652 | 0.821 | 0.902 | 1.049 | 1.152 | 1.380 | 1.402 | 1.610 | 1.870 | 2.067 | 2.370 | 2.469 | 2.870 | 3.068 |

**Wallace type joints,** shown to the right, are used in place of conventional pipe couplings. The Wallace ferrule is threaded as a standard pipe and is fastened by expanding the end of the tube into the grooves on inside of the ferrule. The tube retains its full wall thickness to resist bursting. For example, a 1 in. tube with 20 percent greater inside area than a 3/4 in. pipe, has only 44 percent of the weight of the pipe. Also, the pressure drop through tubing is much less. Table on left page gives tubing dimensions.



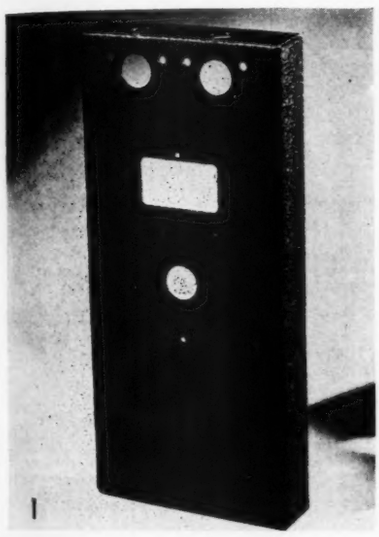

# Conservation by Using Painted Scrap Metal

SCRAP GALVANIZED IRON is being used by one manufacturer for dial panels and scale plates for indicators. Formerly of steel, panels are now finished in crackle paint to cover surface defects.

A fork which was steel is now pressed out of scrapped galvanized iron and gives service equal to that of the old material.

Chromium plate on gages has been replaced by a black finish to match black panels and the result is an improvement in appearance. White metal alloy is now used in place of aluminum for nameplates and metal dials.

To cut down machining, small brass castings are being made in plaster of Paris molds instead of sand.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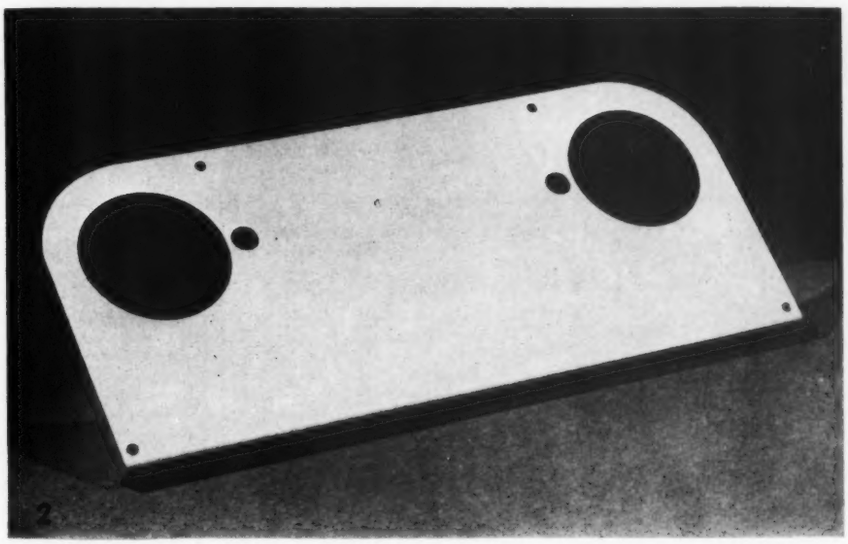
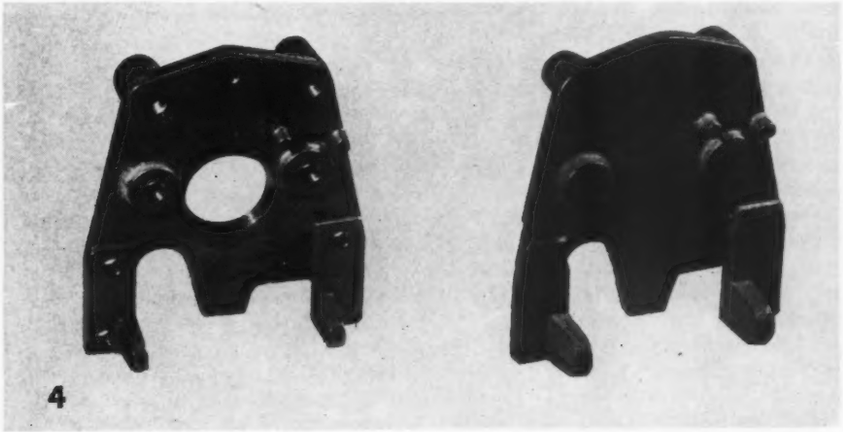

2

*1—Pressed out of scrap galvanized iron, which formerly was thrown away, plates are covered with black crackle finish. 2—Dial panel punched out of scrap galvanized iron is finished in white enamel*


4

*3—Pressed out of scrap galvanized iron, this fork was formerly made of steel. 4—Plaster-cast brass casting (left) saves time required for machining surface of sand casting (right) formerly used*

# FALK SUBSTITUTION RECORD

When it was first realized that substitute analyses for steel and non-ferrous metals would require special attention, the Falk Corporation installed a system which has been in successful operation for some time. The following factors were originally set up as conditions which must be fulfilled.

1. The system must be sufficiently flexible to accommodate any number of different materials since any single approved substitute in itself would not be sufficient. Set substitutes might, in time, become impossible to obtain.

2. Cognizance had to be given the fact that the original specification of a material was largely a matter of standardization, experience and personal opinion. Therefore a considerable number of commercially available steels, properly heat-treated, could provide adequate engineering properties for satisfactory service performance.

3. To provide the proper properties, full information on the optimum heat-treatment of the substitute material had to be supplied the heat-treating department.

4. Shop production and inspection could be facilitated and difficulties minimized if proper instructions and identification were provided at all stages of manufacturing.

5. Research and investigation of the newer substitutes available had to be expedited through the metallurgical laboratory in periods measured by hours and days rather than in weeks.

6. The condition of steel production would demand the utilization of "off analyses" materials with high residual alloys and steels melted by various processes. For example, acid steels have generally higher hardenability and require lower quenching temperatures and higher draws than basic steels. The melting method must be supplied the heat-treating department if uniform results are to be obtained.

7. Because of the indefinite status of any substitute materials, it would not be feasible to revise drawings for each material supplied. Hence, adequate records had to be maintained.

8. The use of substitute materials, required by necessity, provides an ideal means for obtaining service records of various materials. Hence, records of substitutes were necessary if advantage was to be secured of such service performance data.

THE FALK CORPORATION MILWAUKEE WISCONSIN

TO STATIONS Purch. Dept.
Metallurgical Lab.
Heat Treat
Production Dept.

**MATERIAL SUBSTITUTION RECORD**

Material Specified: Nickel-Moly Forging
Falk Spec. 3132
M. O. 111-111-11
Dwg. 100-100
Heat Treatment: Quench and Temper 225-260 Brinell
P. O. 11-426

Material Substituted: SAE 1045 Basic Open Hearth

Heat Treatment for Sub. Mt'l: 1550°F. Water Quench - 1000°F. Temper
Inspection 225 Min. Brinell

Material from: XXXX Forger

Revisions Req'd in Operations: Rough Machine before Heat Treating

Remarks: Heat Treat Inspection - Carefully examine "Lip" for Quench Cracks

Date: 1-1-42 Signed: E. J. Wellauer

FORM NO. 14-18

THE FALK CORPORATION MILWAUKEE WISCONSIN

TO STATIONS Purch. Dept.
Metallurgical Lab.
Heat Treat

**MATERIAL SUBSTITUTION RECORD**

Material Specified: S.A.E. 6150 Hot Rolled
M. O. 100-000-00
Dwg. X30000
Heat Treatment: Normalized and Tempered
To Falk Spec. 3046
P. O. 10-000

Material Substituted: S.A.E. 4140 Acid Open Hearth Steel

Heat Treatment for Sub. Mt'l: Oil Quench and Temper
1550° F. Quench - 1200° F. Temper

Material from: XXXX Warehouse

Revisions Req'd in Operations: None

Remarks: Met. Lab. - Request time study department to obtain machining date. Met. Lab. to approve micro-structure.

Date: 1-1-42 Signed: E. J. Wellauer

FORM NO. 14-18

**All the requirements** of the factors listed above were found to be fulfilled by a simple "Material Substitution Record," two examples of which are shown above. The system is best described through them.

At the right, material specified was a chrome-vanadium steel for bolt stock. It could not be secured in time to meet production schedules. (a) Purchasing department informed metallurgist of status and substitutes available. (b) Metallurgist approved purchase of desired substitute. (c) Substitute record is made: 1. addressed to interested parties; 2. identification made as to drawings, purchase order, etc.; 3. original material and heat-treatment filled in for reference; 4. substitute materials recorded; 5. substitute heat-treatment specified, in this case, an oil quench substituted for a previous air quench; 6. no change in manufacturing process required; 7. a request for a study of machinability for future reference.

In the case at the left a nickel-molybdenum steel was impossible to obtain in time with the preference rating of the order. Steps taken in substitution were as follows: (a) Priority manager or purchasing department informed materials engineer of status. (b) Engineering study made to determine whether straight carbon steel might be satisfactory, and the latter found to be the case (sometimes modifications in design are required). (c) Substitution record made as above, with changes in last two parts as follows: Parts rough machined before heat-treating to compensate for lower hardenability of straight carbon steel; inspection required for portion of elements in which hazard of heat-treat cracks might be present with the water quench.

This system has been applied both to government inspection (in which a latitude is allowed in chemical analysis) and commercial production. In all cases it has proved its worth by preventing mistakes and costly delays.